FURUNO

OPERATOR'S MANUAL

DIRECTION FINDER

MODEL FD-160

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FD-160 FREQUENCY TABLE

200 channels are divided into 20 groups, that is scan groups 0, 10, 20 .... 190. Thus the channel scanning is made at every scan group consisting of 10 channels. Group the frequencies according to the name of stations, regions and areas, kind of service, etc.

SCAN	MEMO	FREQUENCY TABLE																			
0		0		1		2		3		4		5		6		7		8		9	
10		10		11		12		13		14		15		16		17		18		19	
20		20		21		22		23		24		25		26		27		28		29	
30		30		31		32		33		34		35		36		37		38		39	
40		40		41		42		43		44		45		46		47		48		49	
50		50		51		52		53		54		55		56		57		58		59	
60		60		61		62		63		64		65		66		67		68		69	
70		70		71		72		73		74		75		76		77		78		79	
80		80		81		82		83		84		85		86		87		88		89	
90		90		91		92		93		94		95		96		97		98		99	
100		100		101		102		103		104		105		106		107		108		109	
110		110		111		112		113		114		115		116		117		118		119	
120		120		121		122		123		124		125		126		127		128		129	
130		130		131		132		133		134		135		136		137		138		139	
140		140		141		142		143		144		145		146		147		148		149	
150		150		151		152		153		154		155		156		157		158		159	
160		160		161		162		163		164		165		166		167		168		169	
170		170		171		172		173		174		175		176		177		178		179	
180		180		181		182		183		184		185		186		187		188		189	
190		190		191		192		193		194		195		196		197		198		199	

FILL IN WITH MEMORIZED FREQUENCIES.

FILL IN WITH NAME OF FREQUENCY GROUP. (STATIONS, REGIONS, AREAS, KIND OF SERVICE, etc.)

⚠ SAFETY INSTRUCTIONS

"**DANGER**", "**WARNING**" and "**CAUTION**" notices appear throughout this manual. It is the responsibility of the operator and installer of the equipment to read, understand and follow these notices. If you have any questions regarding these safety instructions, please contact a FURUNO agent or dealer.

The level of risk appearing in the notices is defined as follows:

⚠ **DANGER**	This notice indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury.
⚠ **WARNING**	This notice indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ **CAUTION**	This notice indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury, or property damage.

⚠ WARNING

Do not disassemble or modify the equipment.

Fire, electrical shock or serious injury can result.

Turn off the power immediately if water leaks into the equipment or the equipment is emitting smoke or fire.

Continued use of the equipment can cause fire or electrical shock.

Do not place liquid-filled containers on the top of the equipment.

Fire or electrical shock can result if a liquid spills into the equipment.

Do not operate the equipment with wet hands.

Electrical shock can result.

Keep heater away from equipment.

Heat can alter equipment shape and melt the power cord, which can cause fire or electrical shock.

⚠ WARNING

Do not work inside the equipment unless totally familiar with electrical circuits.

Hazardous voltage which can shock, burn or cause serious injury exists inside the equipment.

Turn off the power at the mains switchboard before beginning the installation. Post a sign near the switch to indicate it should not be turned on while the equipment is being installed.

Fire, electrical shock or serious injury can result if the power is left on or is applied while the equipment is being installed.

⚠ CAUTION

Do not use the equipment for other than its intended purpose.

Personal injury can result if the equipment is used as a chair or stepping stool, for example.

Do not place objects on the top of the equipment.

The equipment can overheat or personal injury can result if the object falls.

Ground the equipment to prevent electrical shock and mutual interference.

Confirm that the power supply voltage is compatible with the voltage rating of the equipment.

Connection to the wrong power supply can cause fire or equipment damage. The voltage rating appears on the label at the rear of the display unit.

CONTENTS
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1. INTRODUCTION

The Model FD-160 is an MF/HF Direction Finder enhanced by the advanced technology of frequency synthesis. This equipment covers a frequency range from 200kHz to 18MHz as a direction finder and from 100kHz to 29.999MHz as a receiver.

The receiver section is integrated with a micro-computer and features a variety of functions:

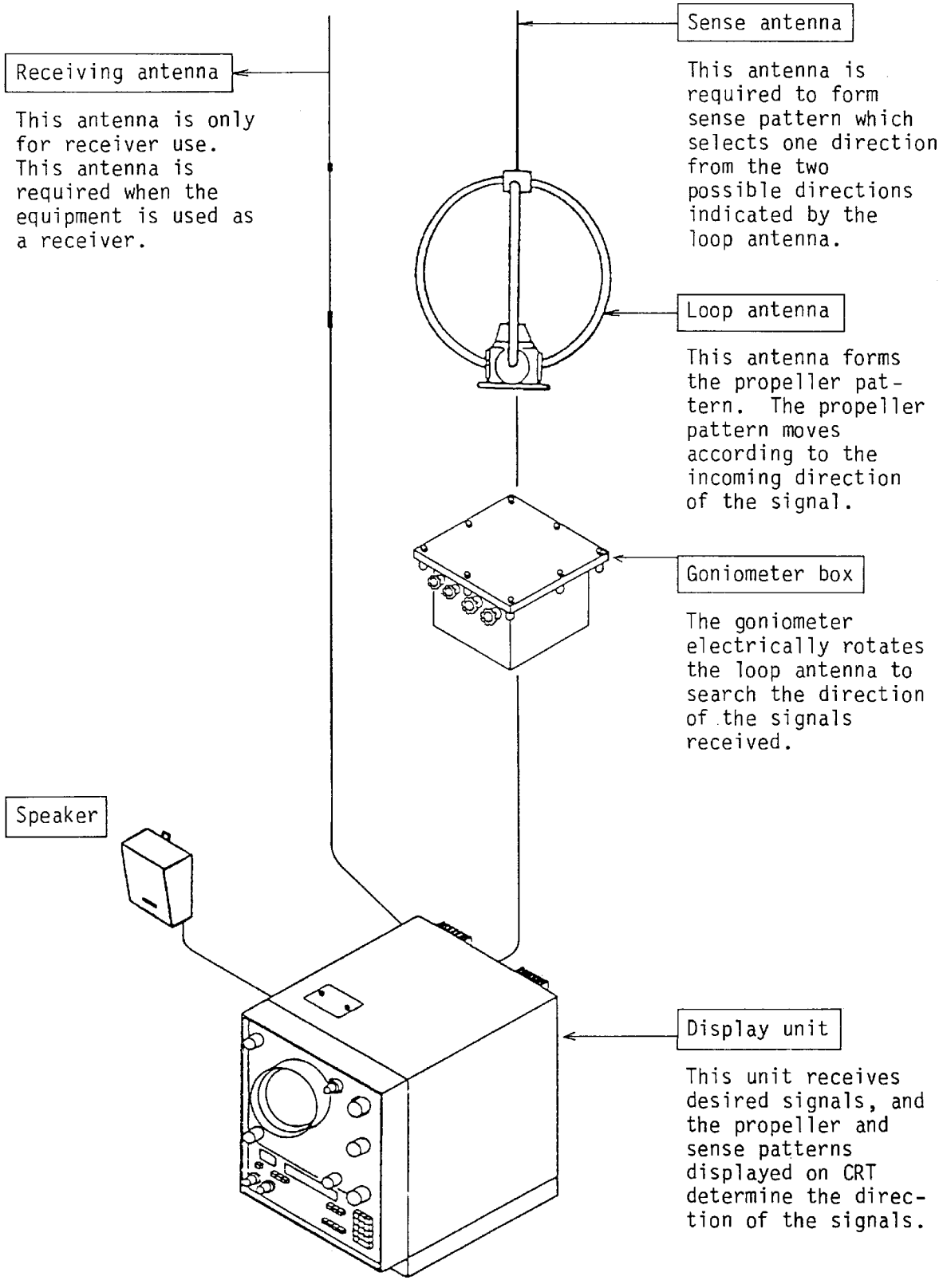
. Frequencies can be digitally set in steps of every 100Hz and can be tuned to optimum conditions through the electronic tuning system.

· Up to 200 frequencies and their emission modes can be stored as easy-to-recall memory channels, thus allowing easy setting of desired signals.

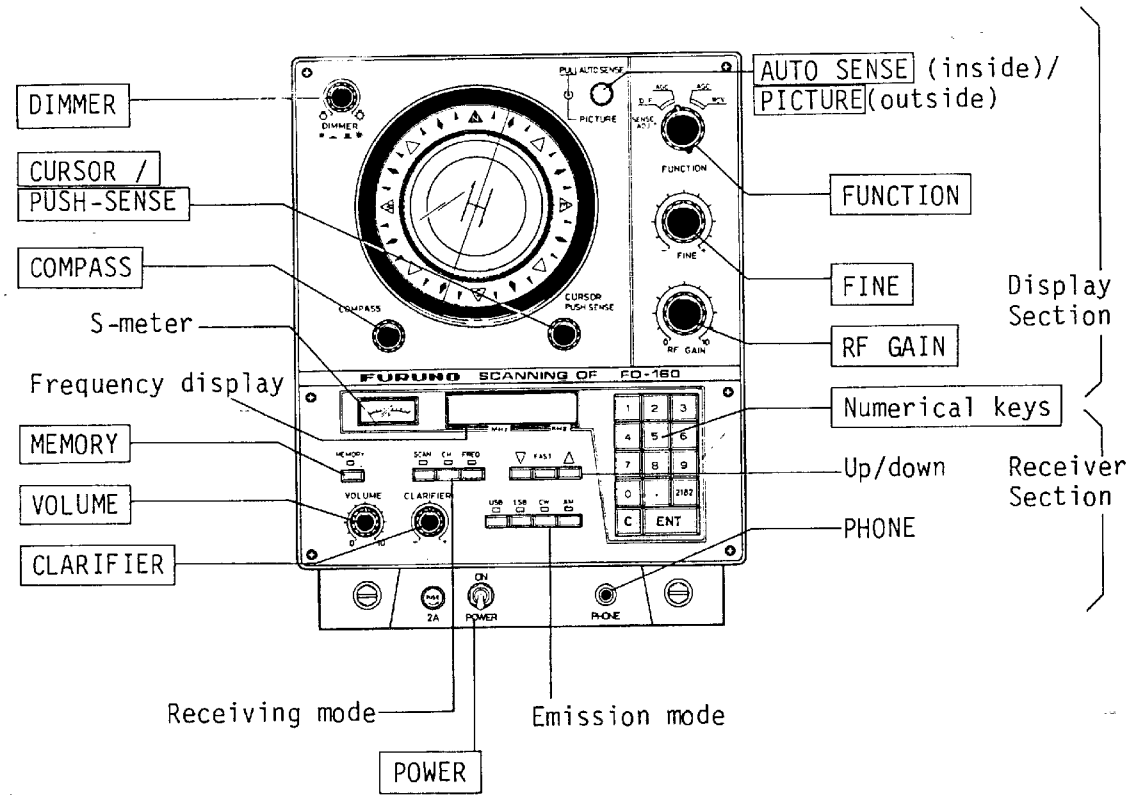
· Frequency scanning/channel scanning enables the search of signals over a desired frequency range or channel groups.

· Easy and fine sense pattern adjustment at display unit. Optimum sense setting can be performed on all frequencies because of finely divided frequency ranges for adjustment/memory.

2. SYSTEM CONFIGURATION



3. SWITCHES, CONTROLS AND KEYS



Display Section

DIMMER :This knob adjusts the illumination of the cursor scale. Pulling this knob increases the brightness of the frequency display and the indication lamps above the pushbuttons.

COMPASS :Rotating this knob with the knob depressed rotates the compass scale to align with the indication of the gyro compass.

CURSOR / PUSH-SENSE :This knob rotates the cursor scale. Pushing this knob displays the sense pattern on the CRT.

AUTO SENSE :Keeping this knob pulled alternately displays the sense and the propeller patterns on the CRT. Rotating this knob adjusts the repetition interval.

PICTURE :Rotating this control adjusts the size of the image displayed on the CRT.

FINE :This knob is used for fine tuning.

FUNCTION :This switch selects the sense adjustment, direction finder mode and receiver mode.

RF GAIN :This control adjusts the gain of the receiver.

Receiver Section

S-meter: This meter indicates the strength of the signals received.

Frequency display: This indicator shows the frequency received or the channel number.

[VOLUME] :This knob controls the sound volume of the external speaker/headphone.

[CLARIFIER] :This knob clarifies the sound/tone when USB, LSB or CW is received.

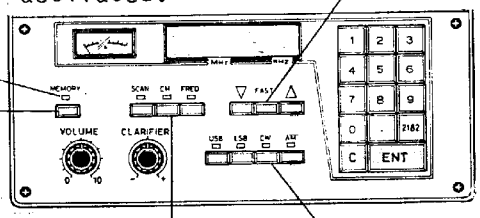
[Numerical keys] :These keys are used when setting the frequency, channel, etc.

PHONE: This jack is for the plug of the headphone.

[POWER] :Turning this toggle switch upward turns on the power source.

[Control Pushbuttons] :These pushbuttons select the emission-modes of receiving signal, receiving mode, etc.

Indication lamp: When this lamp is on, the pushbutton below the lamp is activated.



[▼] / [FAST] / [▲]

These pushbuttons change the frequencies/channels. Pushing the Up [▲] or Down [▼] together with the [FAST] button makes the changing speed rapid.

[MEMORY] :This pushbutton is used to store the channel number/scanning data into memory.

Receiving mode

The receiving modes, [SCAN], [CHANNEL] and [FREQ] are selected.

[CHANNEL] :The preset channel is received.

[FREQ] :Frequencies are received as desired in steps of 100Hz.

[SCAN] :Combined with the [CHANNEL] or [FREQ], scanning of the channels or frequencies are started and stopped.

Emission mode

[USB] / [LSB] / [CW] / [AM]

These pushbuttons select the emission mode of receiving signal.

Button switch	Signal modes received
[USB]	J3E, R3E
[LSB]	Lower sideband of J3E
[CW]	A1A
[AM]	A2A, H2A, A3E, H3E

4. OPERATION SUMMARY

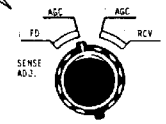
4-1 Direction Finding Procedure

When AGC is on.

Turn on the power source.

FUNCTION setting

Set the switch to the DF/AGC.



FUNCTION

PICTURE adjustment

Excessively large | Proper

Set the RF GAIN to "0", and turn the PICTURE knob to display the image as shown above.

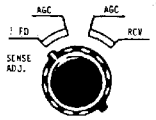
Frequency setting

- Push the FREQ, C, 6, 6, 6 and ENT keys in this order. (A frequency of 666kHz will be set.)
- Push the AM button. (AM mode is selected.)

to be continued

When AGC is off.

Set the switch to the DF.



FUNCTION

For example, to receive a broadcasting signal of 666kHz, AM.

Remarks

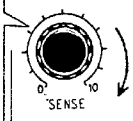
The AGC is a function which maintains the receiver output at a certain level even if the signals received vary in strength.

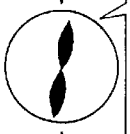
The left example shows the frequency setting method in the "frequency receiving" mode. Other modes are also provided as follows:
- Channel receiving
- Frequency scanning
- Channel scanning

For details, refer to "4-3 Four Receiving Modes"

RF GAIN adjustment

Turn the RF GAIN control fully clockwise.





Turn the RF GAIN control clockwise to display the propeller pattern on the CRT as shown in the left.

When the AGC is on, turn the (RF GAIN) fully clockwise (to the maximum).

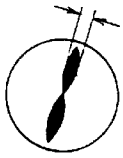
FINE adjustment

Set the FINE control for this maximum S-meter swing.

Adjust the FINE control until the propeller pattern becomes the narrowest.

Width of propeller pattern

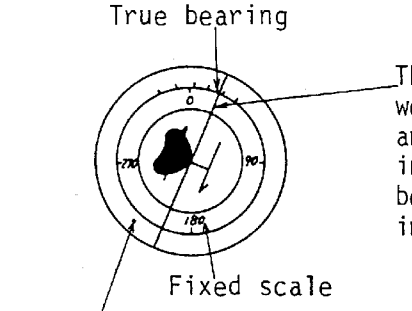
The optimum setting is usually gained when the FINE control is set on or around the midpoint.



Proper

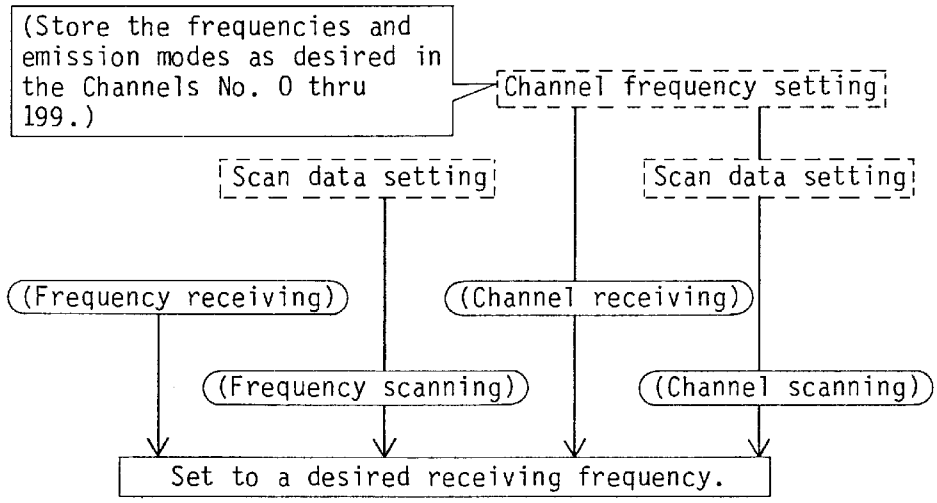
Direction finding

Turn the CURSOR / PUSH-SENSE knob to align the cursor line to the center line of the propeller pattern. Push the CURSOR / PUSH-SENSE knob to determine the sense pattern. The arrow mark on the sense pattern side indicates the direction of the incoming signal.



4-2 Four Receiving Modes

There are four modes for setting the receiving frequencies: (Frequency receiving), (Frequency scanning), (Channel receiving) and (Channel scanning).
In other modes than the frequency receiving mode, the channel frequency and/or the scan data must be previously set in the procedure as shown in the flow chart below.



For detailed operation and setting, refer to "5. Frequency Setting".

(Frequency receiving):When a frequency is required to be occasionally received, the frequency is set by manually entering the data with the numerical keys.

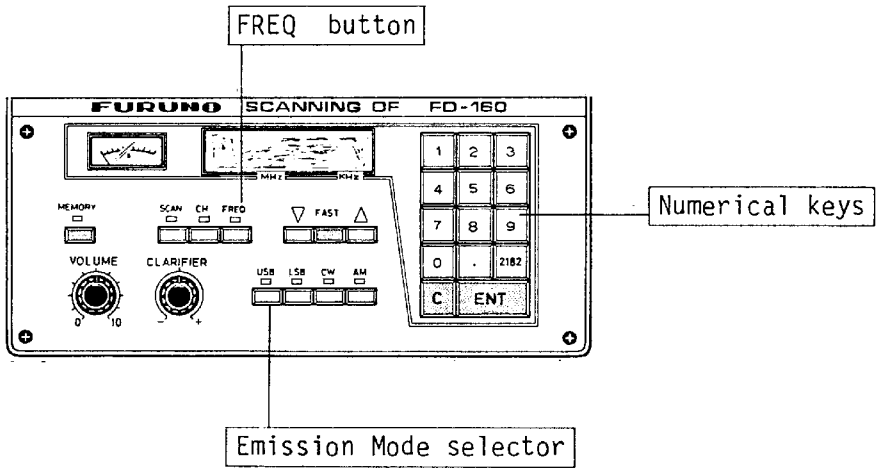
(Frequency scanning) :The frequencies are scanned at desired intervals within a preset frequency range.
This mode is convenient for the search of incoming signals when those frequencies are unknown.

(Channel receiving) :The previously stored channel frequency and emission mode is received by calling the registered channel number.

(Channel scanning) :Previously stored channels in a group are scanned.
This equipment has a capability to store 200 channels (0 to 199) in total and they are divided into 20 groups for channel scanning.
This mode is convenient for the search of incoming signals among preset frequencies.

5. FREQUENCY SETTING

5-1 (Frequency receiving) ···The frequency desired can be entered directly with the numerical keys.



(1) Set the frequency desired to receive.
(The data entered with the numerical keys are entered in "kHz".)

Example 1: When setting a frequency of 2394.5kHz, push the keys in the following order:

[FREQ] [C] [2] [3] [9] [4] [·] [5] [ENT]

Example 2: When setting a frequency of 2232kHz, push the keys in the following order:

[FREQ] [C] [2] [2] [3] [2] [ENT]

· When the number in the place of 100Hz is "0", [·] and [0] need not be entered.

> Caution: When frequencies except 100kHz thru 29.9999MHz are entered, the display flickers to indicate that the frequency can not be entered. Press the [C] key and enter the proper data again.

Example 3: The emergency frequency of 2182kHz can be set only by pushing the [2182] key. At this time, the emission mode is automatically set in the [AM].

(2) Setting the emission mode.

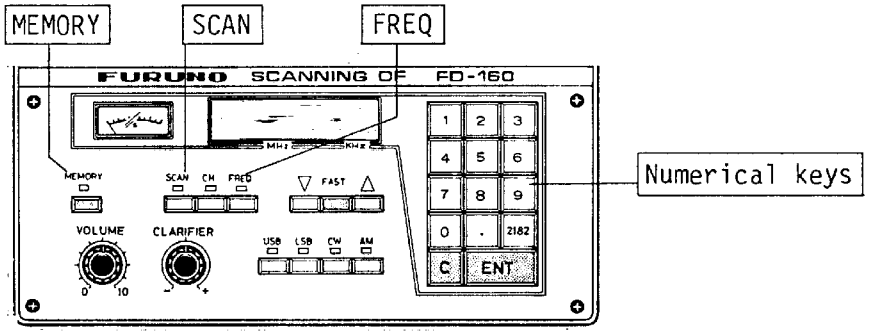
Example: When the emission mode of received signal is J3E, push the [USB] button.

— Related operation/application ———— — ———— — ————————

(1) The procedure to reset the frequency displayed to another frequency.

In case of a slight variation, pushing the button [▼] / [▲] changes the frequency in steps of 100Hz.
Pushing this button together with the [FAST] button rapidly changes the frequency.

5-2 (Scan data setting/Frequency scanning) ····Procedure to scan at certain intevals within a desired frequency range.



Example: When the scanning data is as follows:

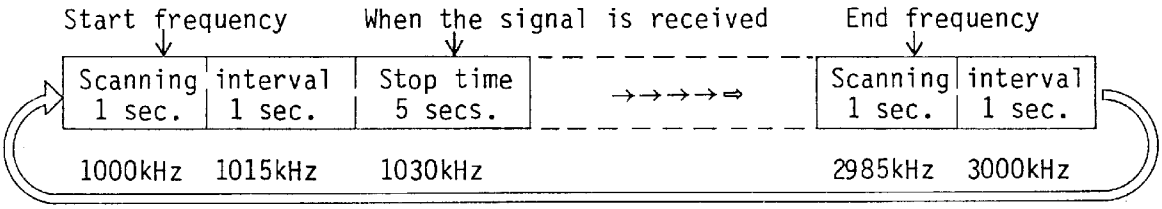
Scanning interval (scanning speed)·····1 sec.

Stop time (when the signal is received)·····5 secs.

Start frequency·····1000kHz

End frequency·····3000kHz

Step frequency·····15kHz



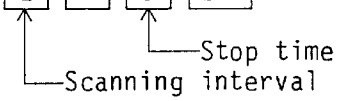
· The frequencies are scanned from the start frequency to the end frequency step by step at preset intervals. When the end frequency is reached, the scanning is restarted at the start frequency.

(1) Select the frequency scan mode by pushing the FREQ and SCAN in this order.

(2) Entering the scan data

· Enter the scanning interval/stop time (unit: second) by pushing the keys in the following order:

[MEMORY] [C] [1] [·] [5] [ENT]



Note: The scanning interval and stop time can be set at 1 thru 9,999 seconds in units of 1 second but the total of both digits can not exceed six.

· Enter the start frequency by pushing the keys in the following order:

[C] [1] [0] [0] [0] [ENT]

Note: Be sure to make the start frequency smaller than the end frequency. If the frequencies are set in the reverse, the display flickers to indicate an error when the scanning is started. In this case, push the MEMORY button to enter the proper data again.

· Enter the end frequency by pushing the keys in the following order:

[ENT] [C] [3] [0] [0] [0] [ENT]

· Enter the step frequency in the following order:

[ENT] [C] [1] [5] [ENT]

(3) Start the scanning by pushing the [SCAN] button.

Note 1: The stop function activates at a signal strength of "3" or more on the S-meter. Set scan threshold level with the [RF GAIN] control.

2: Set the [FINE] control on or around the midpoint.

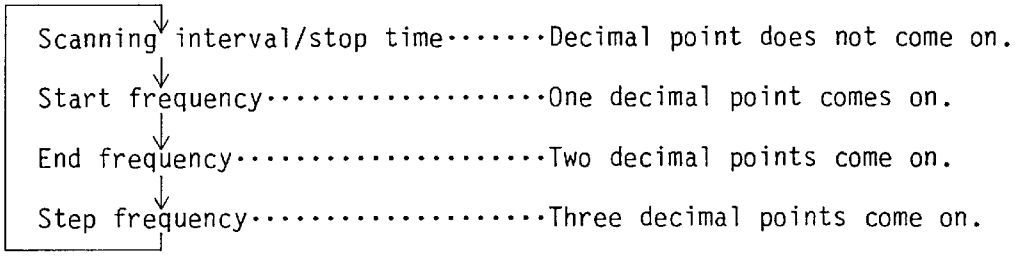
Related Operation/Application

(1) Temporary stop during scanning

Push the [SCAN] button. Push the button again to restart the scanning.

(2) Scan data check/Partial change

Push the [MEMORY] button during scanning.
The scanning interval/stop time are first displayed.
Thereafter, every time when the [ENT] button is pushed, the data are sequentially displayed as follows:



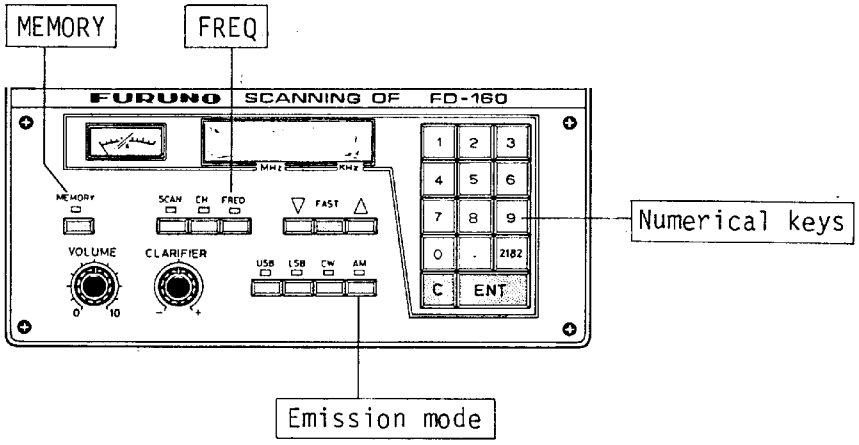
First call the data to be changed, push the [C] key, enter the data and push the [ENT] key.
The data displayed are changed into the data newly entered. Then, push the [SCAN] button. The scanning will be restarted with the renewed data.

(3) To speed up the scanning rate

Push the [▲] or [▼] button. If the button is pushed together with the [FAST] button, the scanning rate becomes faster.

5-3 (Channel Frequency Setting) ·····Procedure to store the frequency/emission mode.

This setting is required before using the channel receiving/channel scanning modes.



(1) Enter the frequency/emission mode as desired.

Example: When entering the frequency 1008kHz/emission mode AM, push the keys in the following order:

FREQ C 1 0 0 8 ENT AM

(2) Enter the channel number in which the above data are entered.

Example: When entering the data into Channel No. 101, push the keys in the following order:

MEMORY C 1 0 1 ENT

Note: In the above operation, the data previously stored are displayed. When no data are stored, "0" is displayed. If the old data is to be stored, push the C key to store the data into the other channel.

(3) To store the new data into Channel No. 101, push the ENT key once again.

Note: The old data previously stored are deleted.

Related Operation/Applications

The frequencies which are used in the channel scan mode should be grouped according to their applications, and the channel numbers and frequencies should be stored with their relationship taken into consideration.
For these requirements, the channel frequencies must be reset.
For resetting, proceed with the following procedure.

(1) Data transfer between the channels

Example: Transfer the frequency from Channel No. 101 to 102.

i) First, call the frequency stored in Channel No. 101 by pushing the keys in the following order:

[CH] [C] [1] [0] [1] [ENT]

ii) Transfer the frequency data into Channel No. 102.

[MEMORY] [C] [1] [0] [2] [ENT] [ENT]

> Note: The above operation deletes the data stored in Channel No. 101 and automatically transfers frequency/emission mode data from Channel No. 101 to 102.

(2) Channel memory clear

- When the data stored in a channel are desired to be deleted:

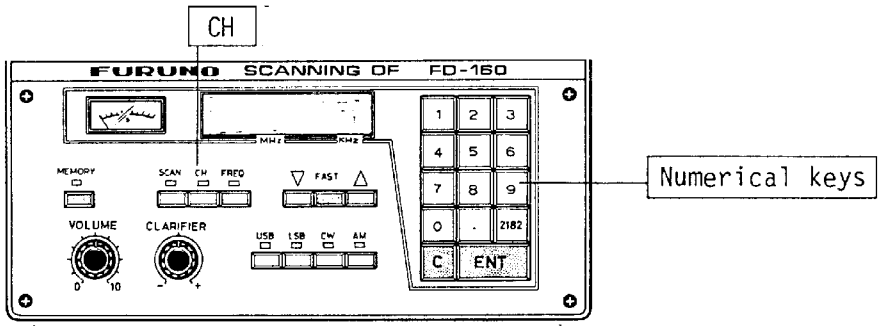
  Example: Delete the frequency stored in Channel No. 101 by pushing the keys in the following order:
  (In this case, the frequency "0" is stored in Channel No. 101.)

  [FREQ] [C] [ENT] [MEMORY] [C] [1] [0] [1] [ENT] [ENT]

- Delete all data stored in all Channels 0 thru 199 by pushing the keys in the following order:
  (In this case, the frequency "0" is stored in Channel No. 999.)

  [FREQ] [C] [ENT] [MEMORY] [C] [9] [9] [9] [ENT] [ENT]

5-4 Channel Receiving ····The procedure for receiving the frequency stored in the channel by calling the channel number.



1. Set the channel number desired in order to receive the frequency.

   Example: When receiving the frequency in Channel No. 101, push the keys in the following order:

   [CH] [C] [1] [0] [1] [ENT]

   · At this time, either the frequency stored in the Channel No. 101 or the channel number is displayed. Further, push the [(ENT)] key. The channel number or the frequency will be alternately displayed each time the key is pushed.

> Note: When the display flickers, no frequency is stored in the called channel number. In this case, newly store the frequency.

Related Operation/Applications

The following operation can also change the channel/frequency.

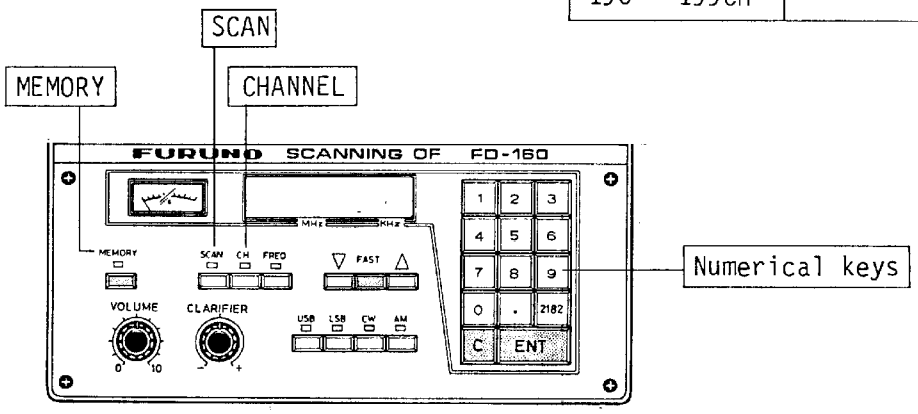
(1) When the [▲] or [▼] button is pushed with the channel number displayed, the channels stored with the frequencies are sequentially displayed. Pushing the button together with the [FAST] button increases the changing speed.

(2) The following operation in the channel mode can easily change the frequency into the adjacent frequency.
The frequency in the channel is displayed when the [MEMORY] and [FREQ] buttons are pushed. Then, pushing the [▲] or [▼] button increases or decreases the frequency in steps of 100Hz. Pushing the button together with the [FAST] button increases the changing speed.

5-5 (Scan data setting/Channel scanning) ···The procedure to scan the stored channels over a group of 10 channels.

The channels are divided in 20 groups of 10 channels as shown in the right table. The channels desired to scan can be selected as a unit of this group. For example, selecting the scanned groups 10 and 30 sequentially scans only the channels stored over Channel Nos. 10 thru 19 and Nos. 30 thru 39.

Channel No.	Scanned group
0 ~ 9CH	0
10 ~ 19CH	10
. . .	. . .
190 ~ 199CH	190



Example: The following scan data are desired to be stored:

Scanning interval (scanning speed)·····2 sec.

Stop time (when the signal is received)···30 secs.

Scanned group numbers·····10 and 30

(1) Select the channel scanning mode by pushing the buttons in the following order:

[CH] [SCAN]

(2) Enter the scan data.

· Enter the scanning interval/stop time (unit: second) by pushing the keys in the following order:

[MEMORY] [C] [2] [.] [3] [0] [ENT]

Stop time

Scanning interval

Note: The scanning interval and stop time can be set at 1 thru 9,999 seconds in units of 1 second but the total of both digits can not exceed six.

· Enter the scanned group numbers by pushing the keys in the following order:

[C] [1] [0] [ENT] [C] [3] [0] [ENT]

Scanned group No.

(3) Start the scanning by pushing the [SCAN] button.

Note 1: The stop function activates at a signal strength of "3" or more on the S-meter. Set scan threshold level with the [RF GAIN] control.

2: Set the [FINE] control on or around the midpoint.

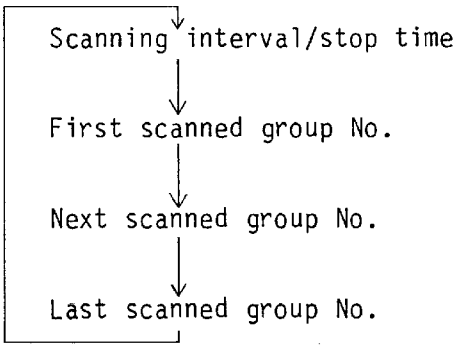
Related Operation/Applications

(1) Temporary stop during scanning

Push the [SCAN] button. Push the button again to restart the scanning.

(2) Scan data check/partial change

· Push the [MEMORY] button during scanning.
The scanning internal/stop time are first displayed.
Thereafter, every time when the [ENT] button is pushed, the data is sequentially displayed as follows:



· Scanning interval/Stop time change

When the scanning interval/stop time is displayed, proceed with the same procedure as described in Step (2) "Entering the scan data".

· Scanned group change

When a scanned group is desired to be deleted, ···
Push the [C] [ENT] when the affected scanned group is displayed.

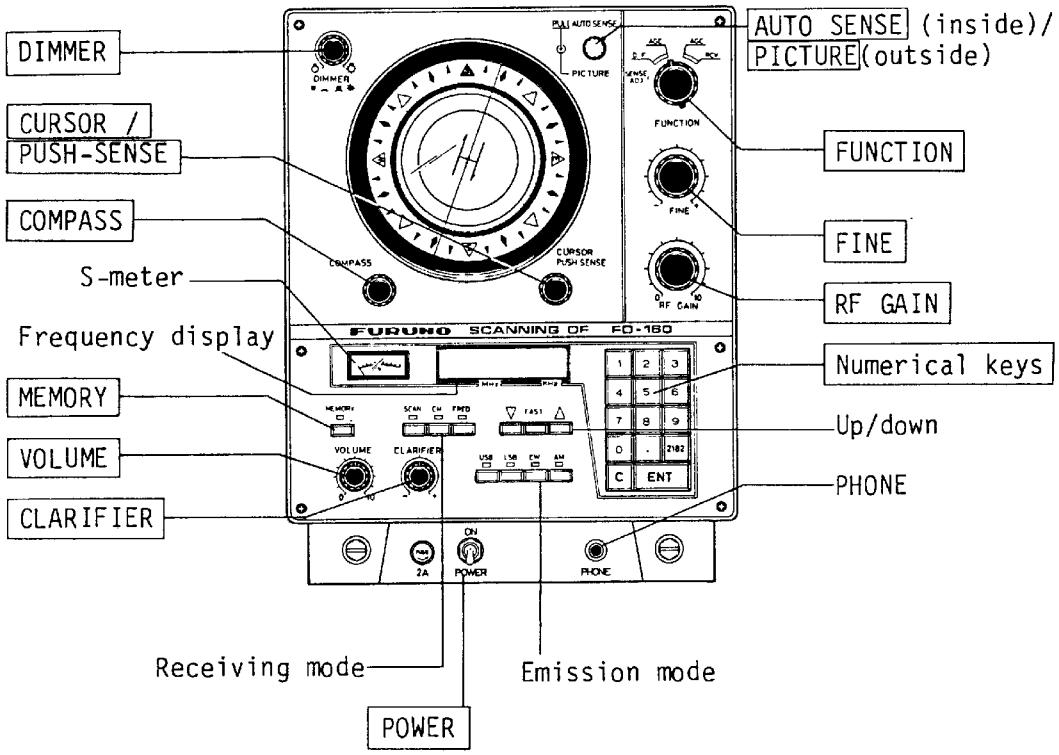
When a new scanned group is desired to be added, ···
Proceed with the same procedure as described in Step (2) "Entering the scan data" even when any scanned group is displayed.

(3) To speed up the scanning rate,

Push the [▲] or [▼] button. If the button is pushed together with the [FAST] button, the scanning rate becomes faster.

6. DIRECTION FINDING OPERATION

6-1 Operating procedure



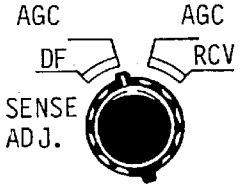
(1) Turn the [POWER] toggle switch upward to energize the system.

(2) Turn the [DIMMER] control to adjust the brightness of the cursor scale and frequency display.

(3) When the gyro repeater is incorporated, turn the [COMPASS] knob with the knob pushed to align the compass scale to the reading of the gyro compass.

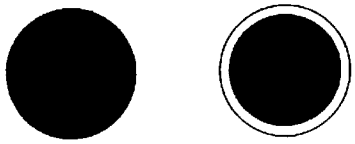
(4) Set the [FUNCTION] switch at the AGC on the DF side.

- For details, refer to "Operation for [FUNCTION] switch" in page 6-4.



FUNCTION

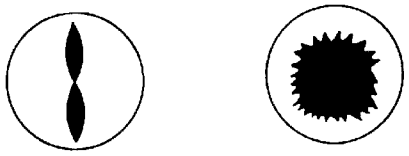
(5) Set the [RF GAIN] control at "0" and turn the [PICTURE] control to make the round image cover about 95% area of the CRT.



Excessively large Proper

(6) Turn the [RF GAIN] control clockwise close to the midpoint and set the [FINE] control at the center.

(7) Select a desired frequency referring to "5. Frequency Setting".



When a signal is received When a signal is not received

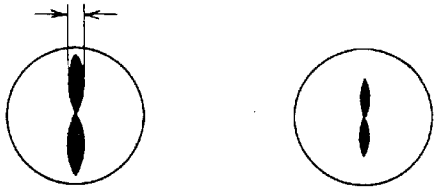
(8) Adjust the sound volume with the [VOLUME] control.

(9) When the signal received is [USB], [LSB] or [CW], turn the [CLARIFIER] control to gain fine sound/tone.

(10) Make the width of the propeller image further narrower with the [RF GAIN] and [FINE] controls. After the [FINE] control is adjusted, turn the [RF GAIN] fully clockwise.

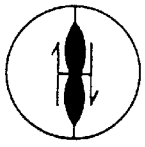
Note: When the AGC is off, the [RF GAIN] must be adjusted.

Width of propeller pattern



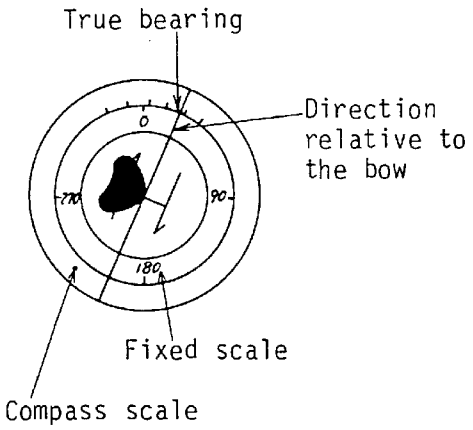
Proper Gain too high

(11) Turn the [CURSOR] knob to align the cursor line to the center line of the propeller pattern.



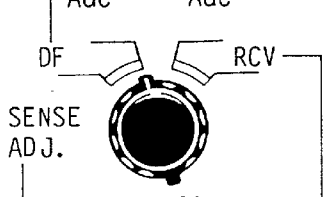
(12) When the system is not coupled with the gyro-compass, turn the [COMPASS] knob with the knob depressed to align the compass scale to the reading of the ship's compass.
(This operation is not necessary to measure relative bearing of incoming signal.)

(13) When the [PUSH-SENSE] knob is depressed, the propeller pattern will be deformed on one side. The arrow mark on the deformed side indicates the direction of the incoming signal. When the [AUTO SENSE] knob is pulled, the sense and propeller patterns are alternately given. Turning the knob adjusts the repetition interval from 0.5 to 2 seconds.



(14) Determine the correct direction by referring to "Direction Finder Calibration Curve".

· Operation of [FUNCTION] switch



When the equipment is used for direction finding,

DF : AGC (automatic gain control) is off.

AGC: AGC is on.

When the equipment is used as a receiver,

In this case, no image is displayed on the CRT.

When the sense pattern is adjusted,

For the sense pattern adjustment, refer to "8-5 Sense Adjustment".

Note: When the receiving antenna is not provided, the signal can not be received at this position of the switch. In this case, set the switch at the "DF" mentioned above.

RCV: AGC is off.

AGC: AGC is on.

Note: Function of AGC

(1) When AGC is on,

For signals with their strength varied, turn the RF [GAIN] fully clockwise. Adjust the [FINE] control until the S-meter swings to its maximum point. Then, a stable propeller pattern and sound will be gained.

(2) When AGC is off,

. This mode is effective to find the maximum tuning point with the [FINE] control.

. The scan threshold level for frequency scan/channel scan can be set.

6-2 Measuring Range to a Transmitting Station

The range from own ship to a transmitting station can be measured two ways: by observing S-meter deflection or noting gain control setting. This feature is useful when you want to know the range to the transmitting station when it cannot be measured by radar.

CAUTION

1. The range data generated by this unit are approximations only and thus should be verified against other range-measuring devices.
2. The reliability of the data depends partly on signal quality. Poor signal quality or an obstruction within the propagation path (for example, an island exists between the transmitting station and own ship) tend to decrease accuracy.

1) S-meter Deflection

Range measurement by this method is basically done by observing the degree of meter deflection; the higher the meter reading, the shorter the range to the transmitting station.

Procedure

1. Measure and record the range to the transmitting station by radar.
2. Receive a signal from the transmitting station and note the degree of S-meter deflection.
3. After some time has elapsed, rereceive the signal from the transmitting station. (Do not adjust the RF GAIN control after this adjustment.) The estimated range to the transmitting station can be found in the table below.

Example

The radar range to a partner ship (in this case the transmitting station) is 15 miles and the S-meter reading is 7. Later, when the target echo disappears from the radar screen, the S-meter reads 2. In this case the range to the ship is 30 miles (see the table below).

S-meter reading	[Far] ← [Initial Data] →		→	→	→	→	→	[Near]	
	1	[2]	3	4	5	6	7	8	9	10
Sensitivity	×1.2	×1.0	×0.9	×0.8	×0.7	×0.6	×0.5	×0.4	×0.3	
Range (in mile)	36	30	27	24	21	18	15	[12]	9	
	24	20	18	16	[14]	[12]	[10]	8		
	18	[15]	13.5	[12]	10.5	9	7.5			
	12	[10]	9	8	7	6				
	9.6	8	7.2	6.4	5.6	4.8				

2) Gain Control Setting

Range measurement by this method is basically done by noting gain control setting; the higher the setting the greater the range to the transmitting station.

Procedure

The procedure is basically the same as for the measurement by S-meter deflection except that the propeller pattern is used as the receiving sensitivity reference.

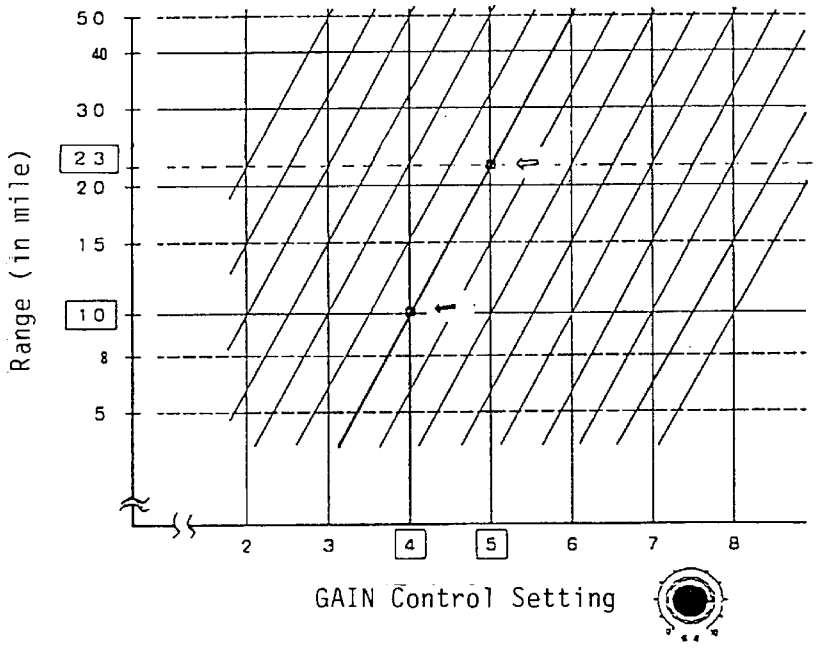
1. Measure and record the range to a transmitting station by radar.

2. Receive a signal from the transmitting station and properly adjust RF GAIN control to obtain proper propeller pattern. Note the RF GAIN control setting.

3. After radar contact with the transmitting station is lost, rereceive the signal and adjust the RF GAIN control to restore initial propeller pattern. Using the radar-measured range and the gain control setting, find the range to the transmitting station in the table below.

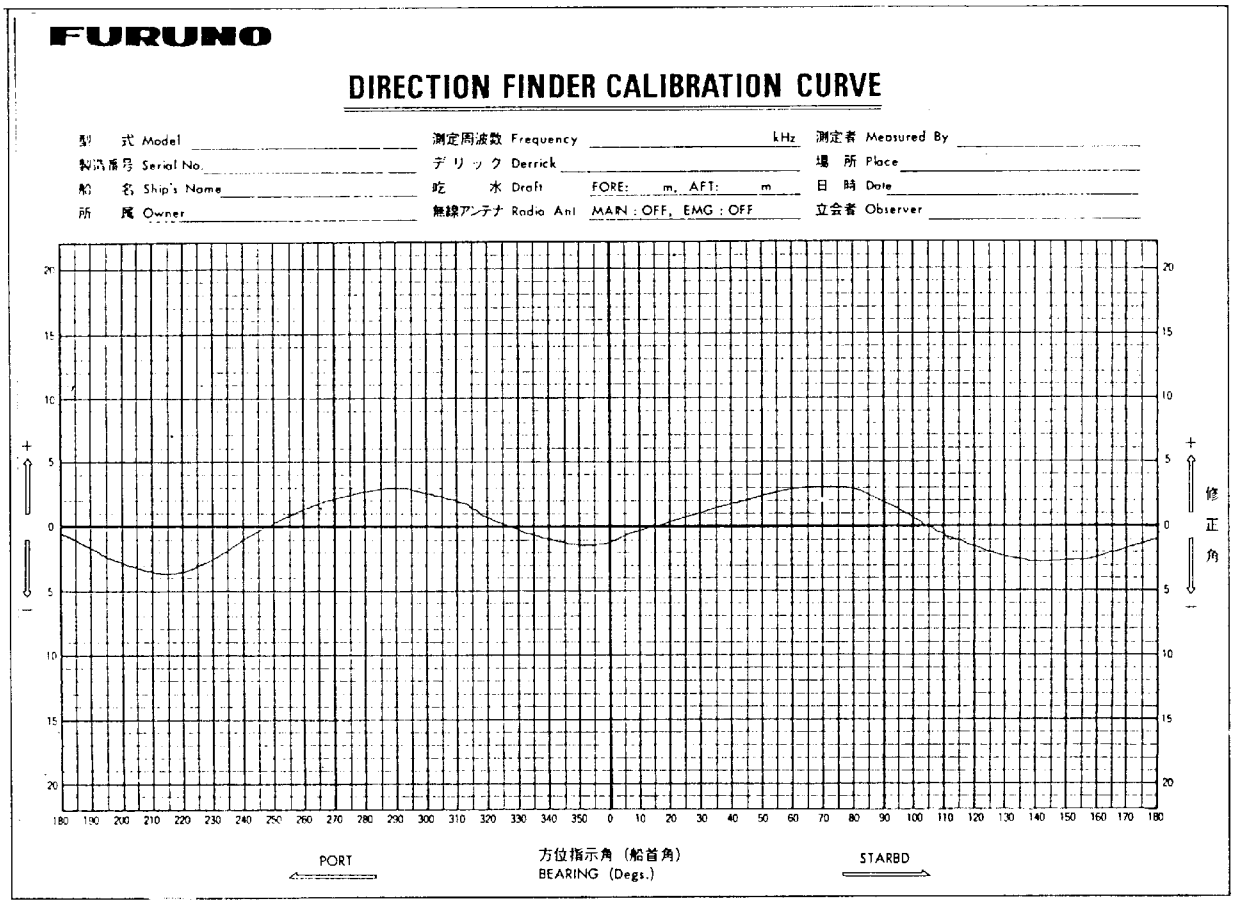
Example

The radar range to a partner ship is 10 miles and the gain setting is 4. Later, just when the target echo disappears from the radar screen, the gain setting used is 5. In this case the range to the target is 23 miles.



6-3 Calibration Curve

Depending on the surrounding conditions of the loop antenna, the direction found by the direction finder usually deviates slightly from the true direction.
Since the direction error can be read on the "Direction Finder Calibration Curve", compensate the direction using the following procedure.



· Example of error correction:

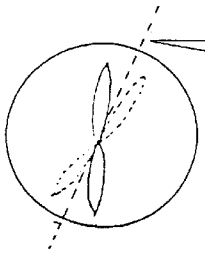
To find the correct direction when the propeller pattern stands at 50 degrees on the fixed scale and 90 degrees on the compass scale:
First find the correction value against the fixed scale angle of 50 degrees on the "Calibration Curve".
If +2.5 degrees is read on the curve, the correct direction of the incoming signal is calculated by adding 2.5 degrees to the propeller indication.

· Direction relative to the bow·····50 + 2.5 = 52.5 (degrees)

· True bearing·····90 + 2.5 = 92.5 (degrees)

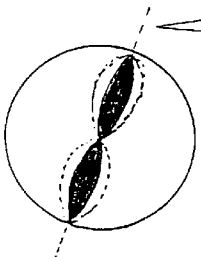
6-4 Direction finding for unstable propeller pattern

(1) When the propeller pattern fluctuates over a wide range:



Regard the center line of the fluctuation range as the incoming direction of the signal.

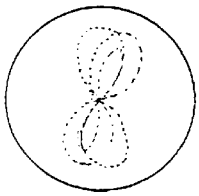
(2) When the propeller pattern varies in width:



Read the direction when the propeller is the narrowest.

(3) When the propeller pattern fluctuates 10 degrees or more, do not use the signal for direction finding.

(4) When the propeller pattern shows not sharp but round tips and fluctuates in size and angle, do not use the signal for direction finding.



7. MAINTENANCE AND TROUBLESHOOTING

7-1 Maintenance

The Model FD-160 Direction Finder is carefully designed to be moisture-proof, corrosion-resistant, vibration-resistant, etc. for marine use. However, to preserve the initial performances for a long period of use, the following cares should be taken during operation.

(1) Shut down the power supply when the unit is not used.

(2) Keep the display unit away from sea water. Do not operate the knobs, controls, etc. with dirty hands. Dirty knobs, etc. should be cleaned with a dry, clean cloth.

(3) Since the loop antenna and goniometer box are directly exposed to wind and rain, they are subject to corrosion. Paint them every six months to a year. The rubber which is used as packing for the loop antenna is liable to deterioration. Therefore, replace the rubber packing before deterioration occurs.

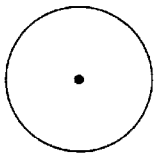
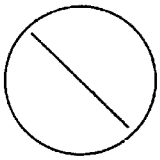
(4) When the unit is not used for one month or more, occasionally operate the unit for about thirty minutes to remove moisture and operate the switches, knobs, etc. to prevent them from poor contact. When the unit is not used for three months or more, the nickel-cadmium battery which maintains the channel frequencies in the memory may be thoroughly discharged. In this case, the memorized frequencies will be erased. To prevent erasure, the battery should fully be charged for about 2 days. When the battery is thoroughly discharged, and the memorized frequencies are erased, re-enter the frequencies into the channels. Then, keep the power source turned on for 2 days to thoroughly charge the battery.

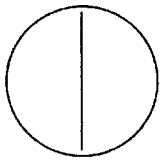
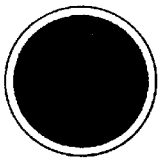
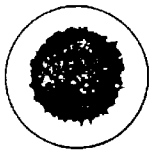
(5) In addition to the nickel-cadmium battery on the control circuit board (07P2122) used to maintain the above channel memory, a lithium battery is attached to the sense adjustment board (07P2127) which maintains the sense pattern data in the memory. Since these batteries last about 5 years, they should be replaced every 5 years. However, check the batteries for irregularities such as liquid leakage, etc. every 3 to 6 months. When an irregularity is found, immediately replace the battery.

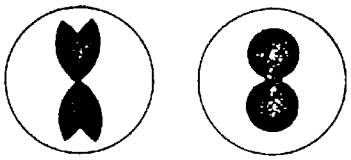
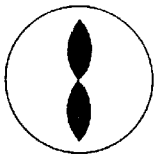
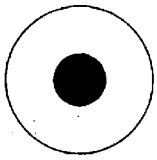
7-2 Troubleshooting

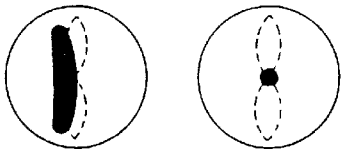
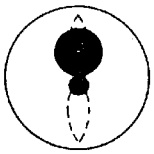
When trouble occurs, please contact our engineer or representative. Only for simple troubles and urgent cases, try to repair the trouble referring to the following table. Since the receiver section has a self-diagnosing function, use this to isolate the trouble and inform our engineer or representative of the result at the time of the service call.

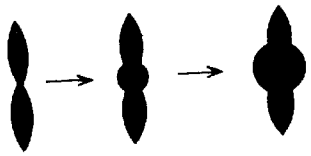
Troubles and suspected causes

Trouble	Symptom	Cause
Power source	1. Neither the illumination lamps nor the frequency display come on.	a. Trouble on the ship power source (including the power distribution board) b. Trouble on the inverter (in case of DC 24V) c. The power source fuse F1 (2A) is blown.
	2. The power source fuse F1 is blown.	a. Short circuit in the transformer T1. b. Defective motor on the goniometer c. Defective power supply circuit (rectifier)
Abnormal image on the CRT	1. No image appears even with proper sound.	a. Defective CRT b. Poor contact of the CRT socket c. Defective high tension circuit (07P2126) for CRT
	2. Only spot appears but the sweep line does not appear. 	a. 23kHz oscillation in video amplifier stops. (Defective Q1,Q2) b. Defective video amplifier Q2 to Q6 (07P2126) c. Defective deflection transformer T4, T5 (07P2126) d. Disconnection between display unit and resolver (in the goniometer box) e. Open circuit in resolver winding or disconnection of wiring f. Defective variable resistor R3 "PICTURE" control g. Defective AGC circuit Q6 to Q8 (when AGC is on) (07P2124)
	3. Straight line in fixed direction 	* The goniometer motor does not rotates. a. Poor contact of the function switch or broken cabling b. Defective or deteriorated phasing capacitor (in the goniometer box) c. Defective motor (in the goniometer box)

Trouble	Symptom	Cause
Abnormal image on the CRT	4. Veritical or horizontal straight line 	* The goniometer motor is rotating. a. Short circuit or broken wiring on the resolver input/output transfer lines or deflection transformers T4 and T5, etc. (07P2126) b. Defective resolver (in the goniometer box) c. Defective deflection circuits for CRT (07P2126)
	5. Only sweeping circles appear but white noise does not sound even if the sensitivity is increased. 	a. Defective goniometer (in the goniometer box) b. Defective preamplifier (07P2117), RF amplifier (07P2121) or IF amplifier (07P2124) c. Poor contact of connectors
	6. Weak white noise sounds even if sensitivity is increased and no propeller pattern appears even if the signal is received. 	a. Broken output wiring of goniometer b. Broken wiring or short circuit of antenna or gonio cable (for both X and Y axes) c. Defective insulation of loop antenna d. Poor contact of connectors
	7. Propeller pattern appears with low sensitivity. 	a. Reduced gain of RF amplifier (07P2121) or IF amplifier (07P2124) b. Poor contact of connectors

Trouble	Symptom	Cause
Abnormal image on the CRT	8. Dual propeller pattern or abnormal propeller pattern 	a. Poor grounding of loop antenna, antenna cable and gonio cable b. Incoming signal disturbed by vertical metallic construction or other antenna c. Interference
	9. Propeller pattern stands only in 0° - 180° or 90° - 270° direction for any signal. 	a. Broken wiring or short circuit in X or Y axis transfer line of antenna cable or gonio cable. b. Broken wiring short circuit in X or Y lines around the gonio stator terminals.
	10. Insufficient image diameter even with PICTURE knob turned fully clockwise (though RF GAIN control is turned fully counter-clockwise) 	a. Detuning at video amplifier T1 or T2 (07P2126) b. Poor contact on 23kHz signal line c. Defective CRT d. Low deflection voltage in CRT (07P2126)
	11. Double circumferences on image 	a. Resolver shaft bent (in goniometer box) b. Defective video amplifier (07P2126)

Trouble	Symptom	Cause
Abnormal image on the CRT	12. Sense pattern appears symmetrically at both sides of propeller. 	a. Defective brilliance modulator circuit Q6 in video amplifier (07P2126) b. Defective brilliance modulator circuit CR1 thru 4 (07P2126) c. Detuning of brilliance modulator circuit T3 (07P2126) d. Poor contact of PUSH-SENSE knob S2 e. Defective relay K1 (07P2119/ in goniometer box)
	13. Propeller pattern is not deformed when PUSH-SENSE knob is depressed. (The sense function is not effective.)	a. Defective sense amplifier (07P2117/ in goniometer box) b. Defective PUSH-SENSE knob S2 c. Broken gonio cable d. Defective relay K1 thru K6 (07P2119/ in goniometer box)
	14. Ambiguous sense pattern 	a. Improper sense adjustment (07P2127) Refer to Appendix-2, "A2-5 Sense adjustment".
	15. Sense pattern on wrong side 	a. Improper sense adjustment Refer to Appendix-2, "A2-5 Sense adjustment". b. Incoming wave disturbed by metallic construction around antenna
	16. Waved image 	a. Sweep voltage modulated by hum noise of power supply Voice is mixed with hum noise. i) Low input voltage ii) Poor grounding of loop antenna, antenna cable or gonio cable b. Defective +12V regulator (07P2125)

Trouble	Symptom	Cause
Audio Sound	Propeller pattern appears but no audio output	a. Defective speaker (loud speaker not built in the display unit) b. Defective AF amplifier (07P2125)
SSB	Voice of received SSB unclear	a. Defective oscillation of BFO circuit Q13, 15 or 17 (07P2124)
Sensitivity	Poor sensitivity	a. Refer to Items 5, 6 and 7 in "Abnormal image on the CRT"
Bearing error	1. Constant error results for any signal	a. Deviated mounting position of CRT b. Deviated mounting position of loop antenna c. Deviated mounting position of stator of gonio or resolver (in the goniometer box)
	2. Propeller pattern stands only in 0 - 180 or 90 - 270 direction.	Refer to Item 9 in "Abnormal image on the CRT"
	3. Error of 5 degrees or more results.	a. Quadrantal error due to ship's body b. Deviated mounting position of loop antenna and CRT c. Incoming wave disturbed by metallic construction around antenna
Other	The center of the propeller swells out as time lapses. 	Defective deflection circuit (07P2126)

Self diagnostic procedure for receiver section

Check of the operation key switches and RAM/ROM in the receiver section is performed as follows.

(1) Turn on the power source switch with the [C] key pushed.

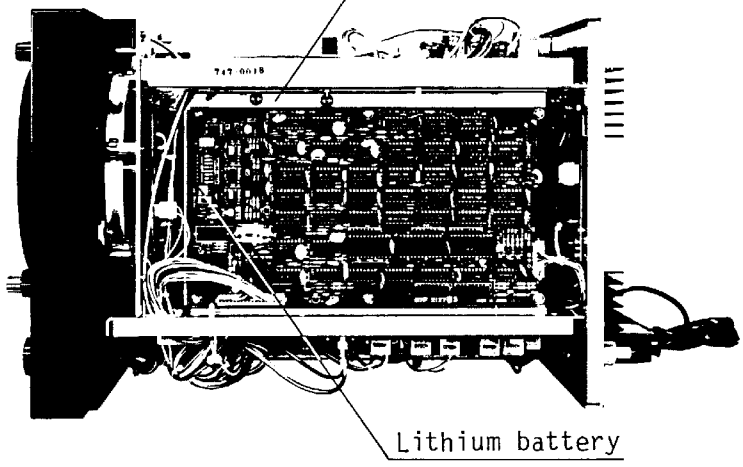
(2) When the [C] key is released, a two-digit number is displayed on the frequency indicator.
(A number except 00 indicates the trouble area.)

Number indicated	Trouble area	Number indicated	Trouble area
11	[1] key	42	[LSB] key
12	[2] key	43	[USB] key
13	[3] key	45	[CW] key
14	[4] key	48	[AM] key
15	[5] key	51	[AGC] key
16	[6] key	61	[2182] key
17	[7] key	62	[C] key
18	[8] key	63	[ENT] key
19	[9] key	70	RAM U16
20	[·] key	80	ROM U15
21	[▽] key		
22	[△] key		
24	[FAST] key		
31	[FREQ] key		
32	[CH] key		
34	[SCAN] key	00	normal (above troubles do not exist.)
38	[MEMORY] key		

(3) Turn off the power source switch.

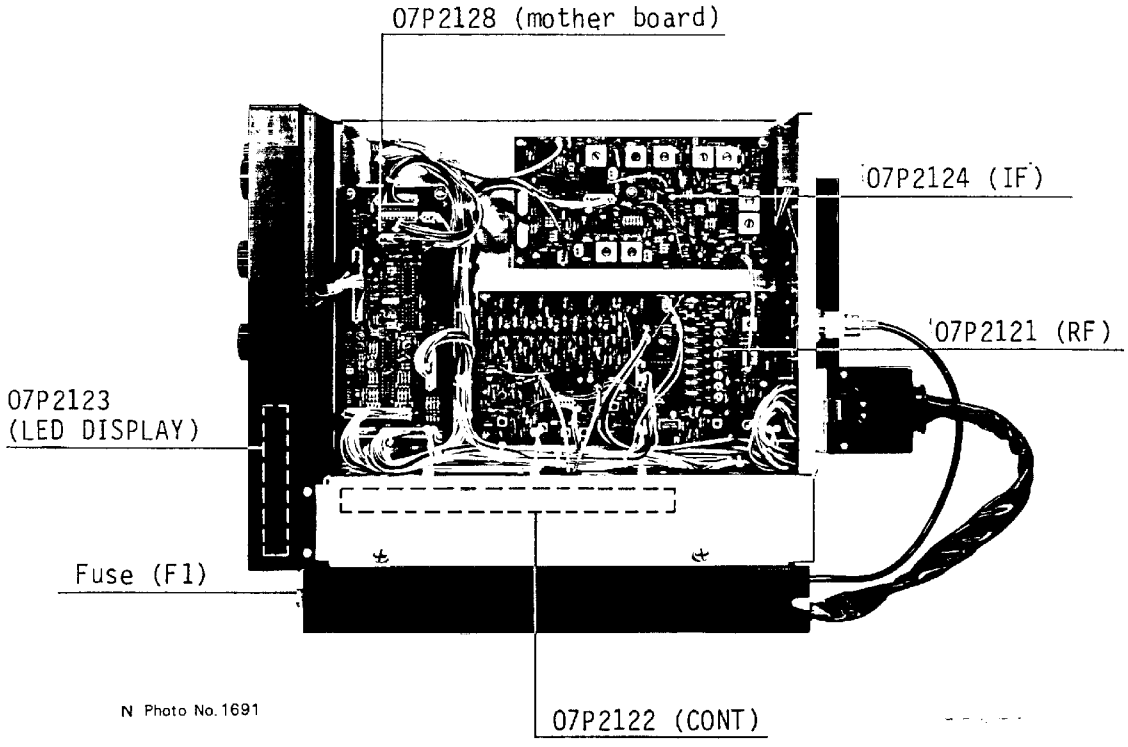
7-3 Parts Locations

(1) Display Unit



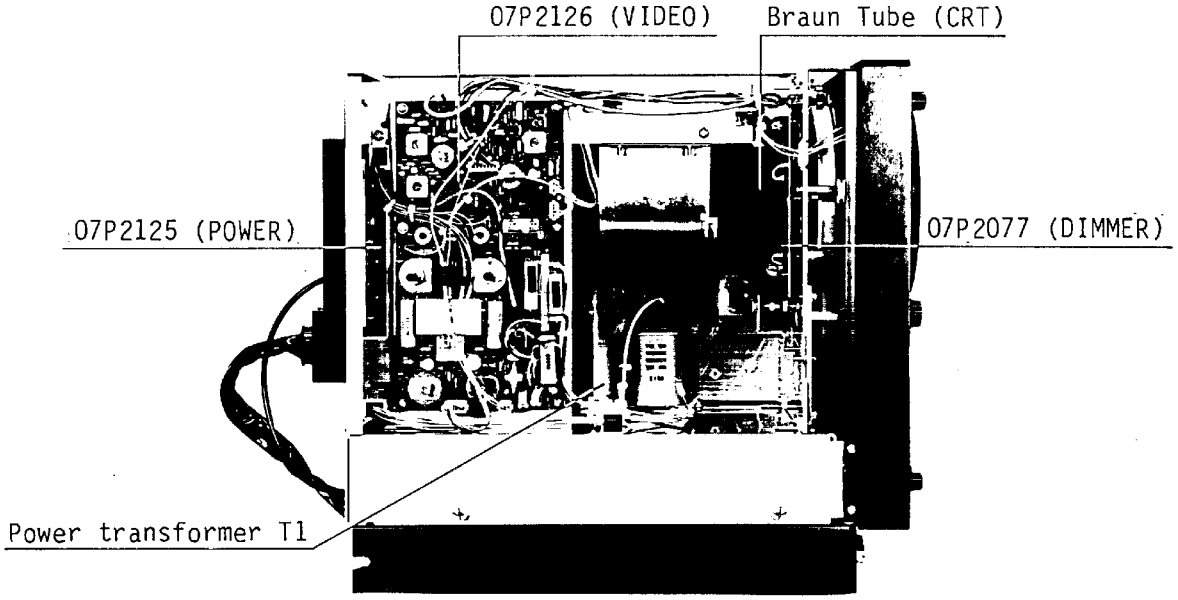
N Photo No. 1692

Top view



N Photo No. 1691

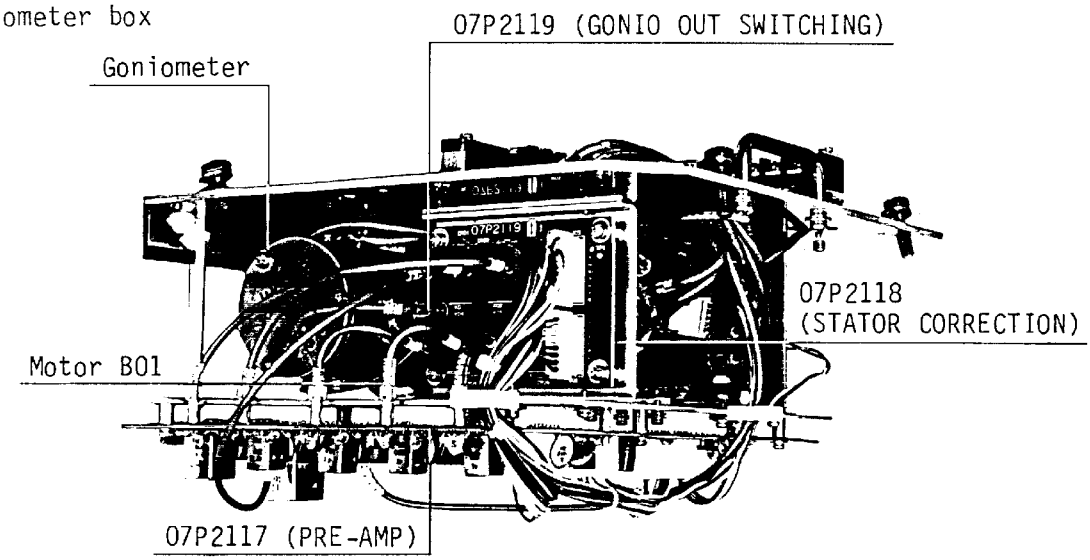
Right side view



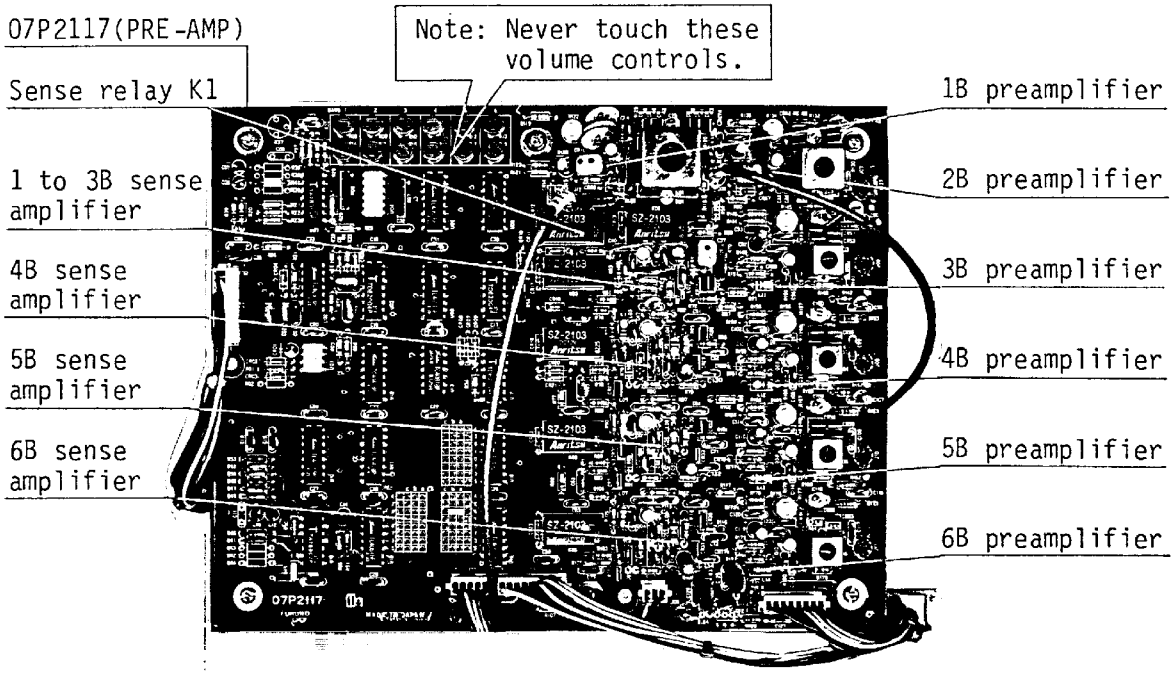
N Photo No. 1690

Left side view

(2)Goniometer box



N Photo No. 1796



N Photo No. 1797

Appendix-1 INSTALLATION

A1-1 Loop antenna

The position where the loop antenna is mounted is very important. Improper positioning results in large direction error, ambiguous sense determination and poor sensitivity. Since the Model FD-160 Direction Finder covers a specially wide frequency range for direction finding, some frequencies are liable to be disturbed. Extreme care should be taken when selecting the mounting position.

(1) Remarks on installation

a) The loop antenna shall be located on the center line of the ship with the BOW mark (triangular mark) facing in the direction of the bow. Since the relationship between the loop antenna and other ship structures becomes asymmetric when the loop antenna is located away from the center line, this may increase the likelihood of error.

b) The loop antenna shall be as far away as possible from metallic objects such as the mast, stay, antenna, antenna feeder line, etc.

c) The loop antenna should not be mounted on an object which has a horizontal component like a slant mast, projected member, etc. or is asymmetric to the loop.

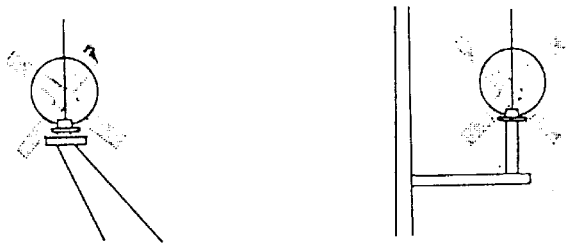


Fig.A1-1

(2) Antenna site

The antenna site shall be selected according to Figs. A1-2 thru A1-5. If the conditions in the figures are not satisfied, the antennas and similar objects around the loop antenna should be located as symmetrically as possible to the loop antenna.

Direction finding up to 18MHz

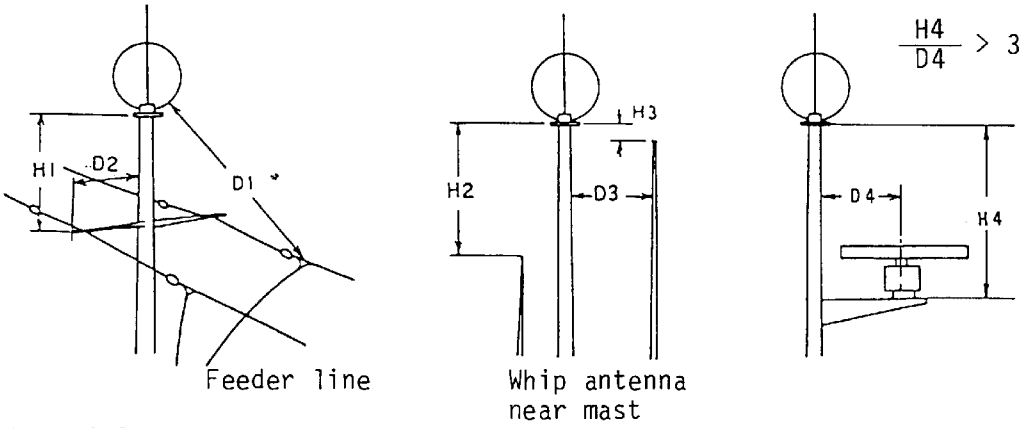


Table A1-1

Fig.A1-2

	H1	D1	D2	H2	H3	D3
Proper	5 or more	6 or more	1.5 or less	3 or more	1 or more	6 or more
Improper	4 or less	4 or less	2.0 or more	1 or less	0 or less	4 or less

Unit: m

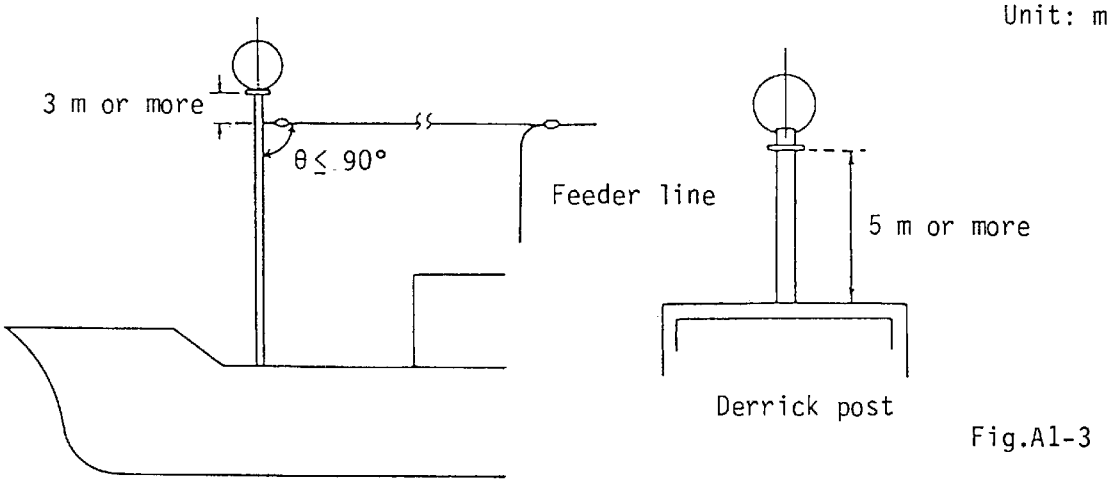


Fig.A1-3

Note:

1. Since main/sub wire antenna, whip antenna and loran antenna with coupler have an adverse effect on the direction finding, the loop antenna should be located away from these antennas.
   (When the length of the antenna is a half or a quarter of the wavelength of the frequency used for direction finding, large influence will result from resonance. In this case, the influence shall be reduced by opening or grounding the antenna with the switch.)

2. The loop antenna shall be as far away as possible from the feeder line.

3. Since the derrick post may cause resonance, the loop antenna should be placed 5 m or more above the derrick post.

Reference: Direction finding up to 2MHz

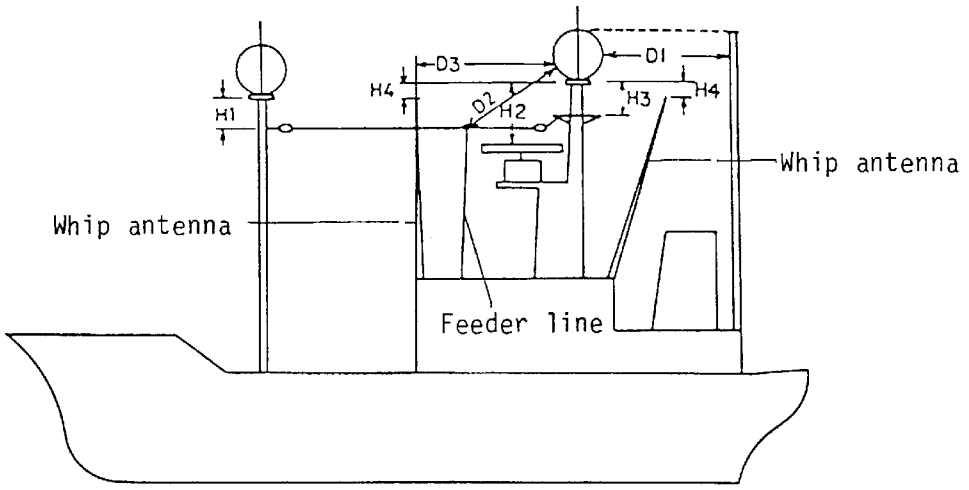


Fig.A1-4a

Table A1-2

	H1	H2	H3	H4	D1	D2	D3
Proper	2 or more	2 or more	2 or more	1 or more	6 or more	6 or more	2 or more
Improper	1 or less	1 or less	1 or less	0 or less	4 or less	4 or less	1 or less

Unit: m

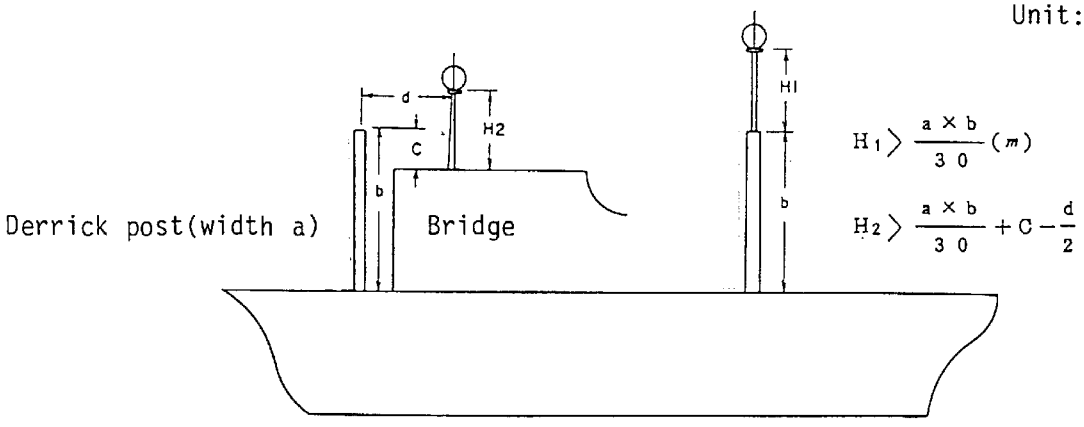


Fig.A1-4b

(3) Mounting

Refer to Figs. A1-5 thru A1-7.
Ground the mounting base to the flange through the bolts.
(Refer to "9-5 Grounding".)

Note: 1. When welding the flange onto the mast, care should be taken for the positioning of the elongated holes relation to the bow direction.
(The cable clamp plate may be placed in any direction.)

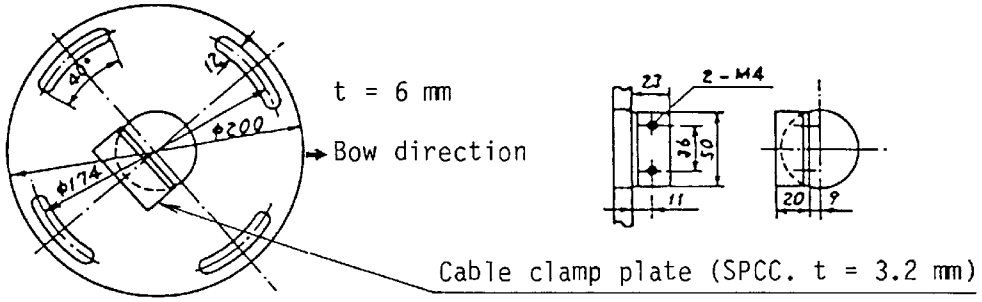


Fig. A1-5a Flange (FDA-18255-3)

2. Never weld the flange with the antenna cable routed through the mast. Otherwise, welding heat will burn the cable.

3. Route the antenna cable (Assembly No. S07-1-8(7P)) through the mast with the end fabricated with crimp-on lugs facing upward, and secure the cable armor with the cable clamp.

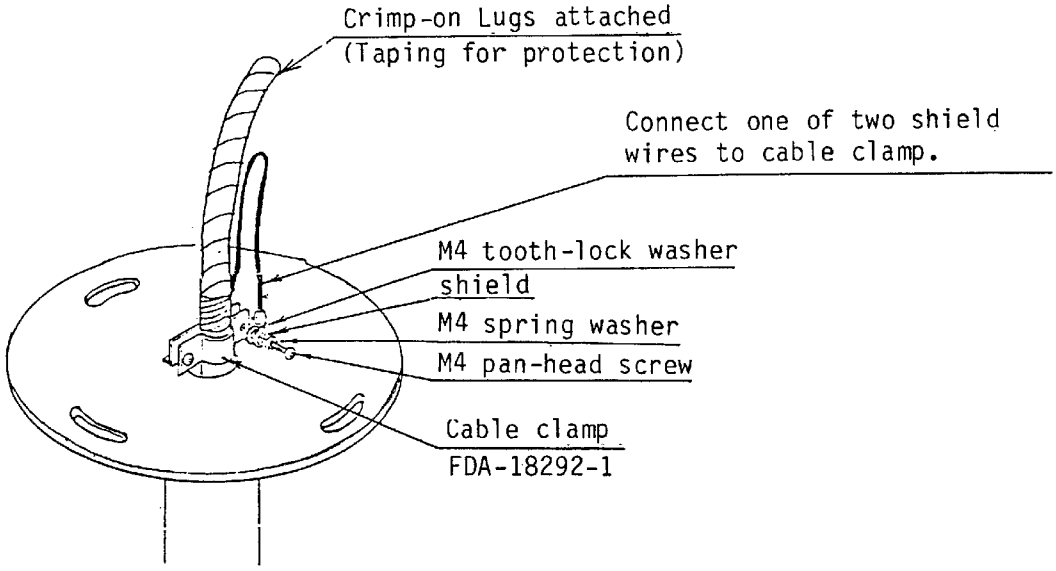


Fig. A1-5a Antenna cable fastening

Prior to fix loop antenna, connect ant. cable to loop ant. terminals as shown in Fig. A1-6.

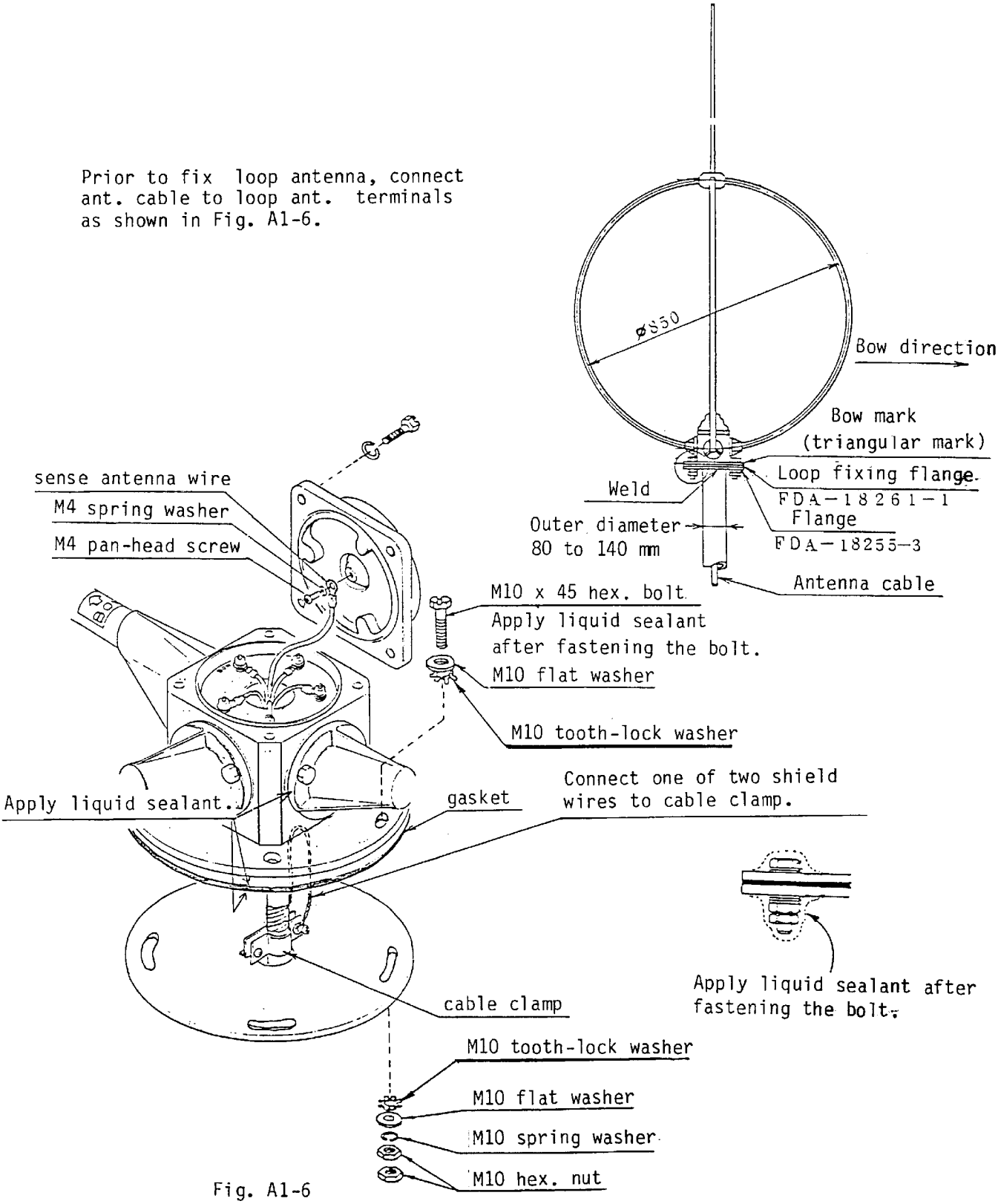


Fig. A1-6

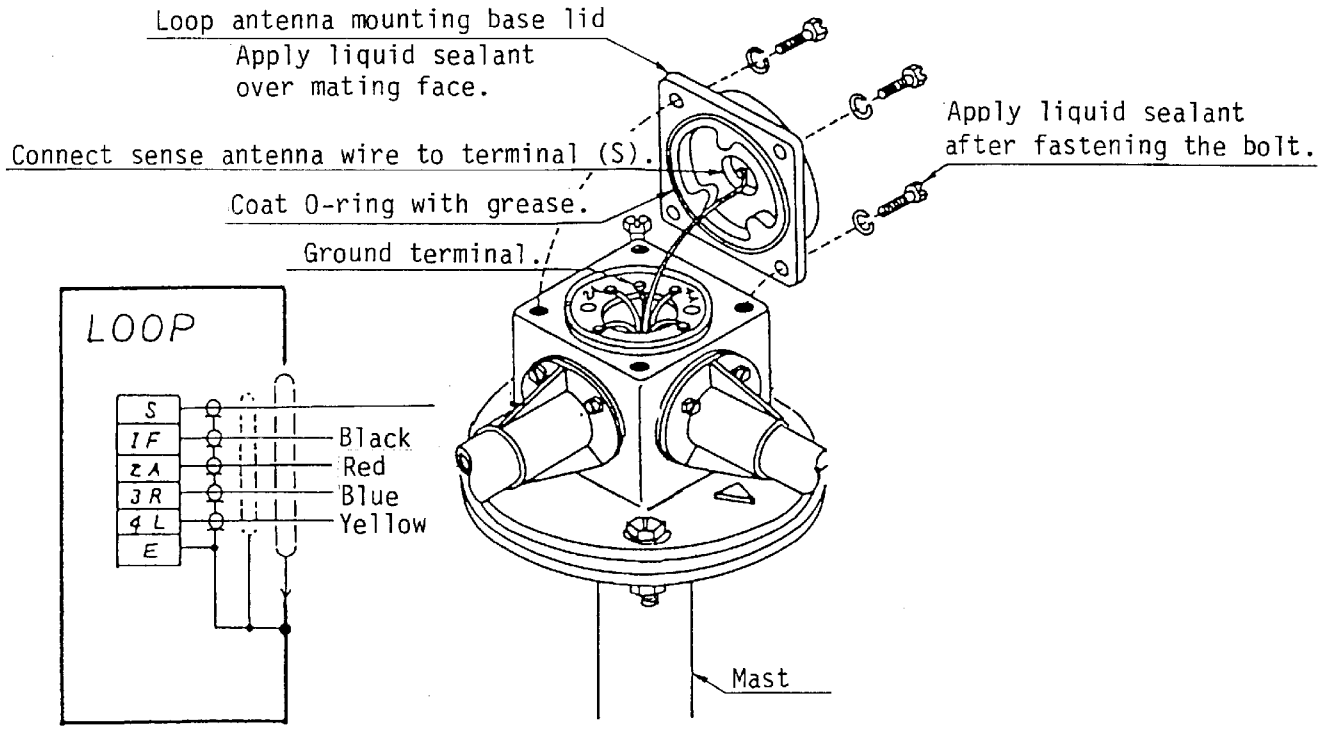


Fig. A1-7 Wiring in loop antenna base

(4) Sense antenna mounting

After the loop antenna is secured, insert the sense antenna through the top of the loop antenna from below and fix the sense antenna with the antenna support hardware. Apply liquid sealant over the junction and the fixing bolts after fastening the bolts.

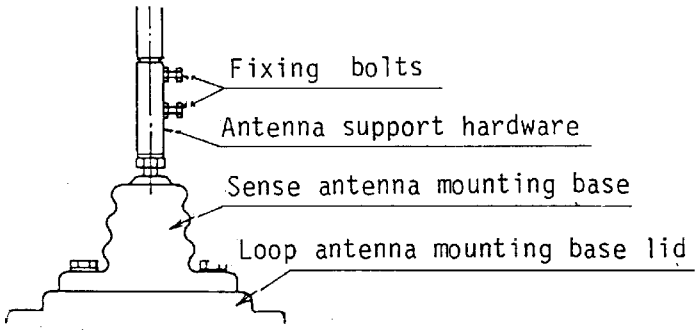


Fig. A1-8

A1-2 Goniometer box

The watertight goniometer box is usually installed outdoors. Since the 8 m long antenna cable can neither be cut nor extended, sufficient care should be taken for the distance between the loop antenna and the goniometer box. Sufficient space should be provided for removal of the lid. When the box is mounted on the aluminum mast, care should be taken for prevention of electrolytic errosion (rubber sheet, etc. should be spread on the box as a countermeasure).
The cables should be routed into the goniometer box through the glands. When routing the cable through the gland, refer to Fig. A1-10 and take special care for tightening strength and watertightness.

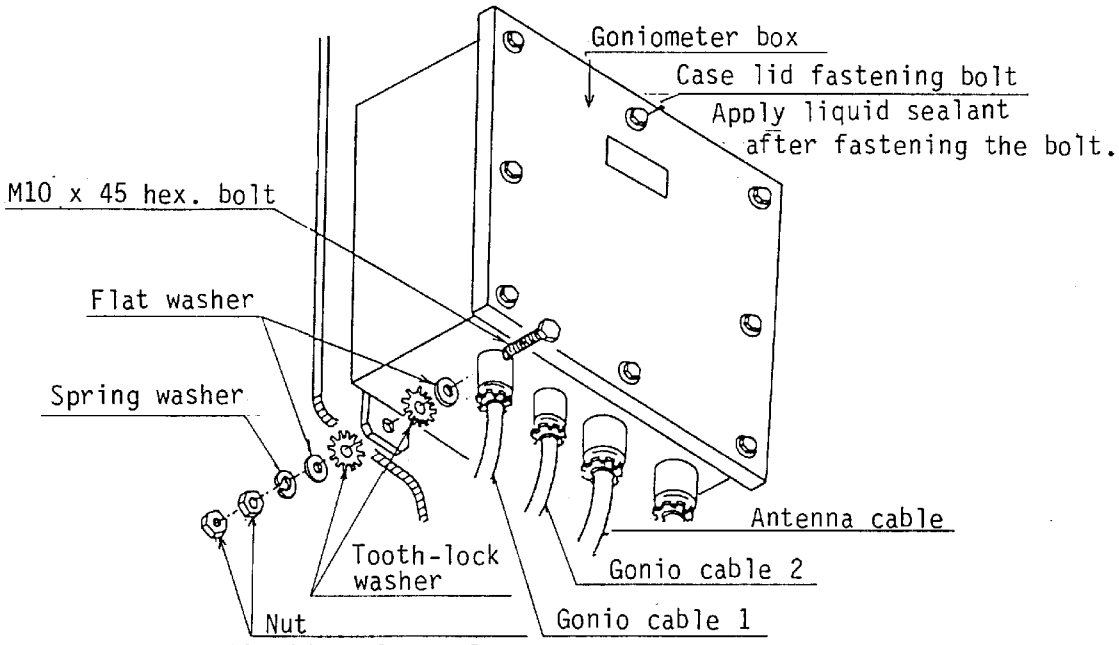


Fig.A1-9 Goniometer box

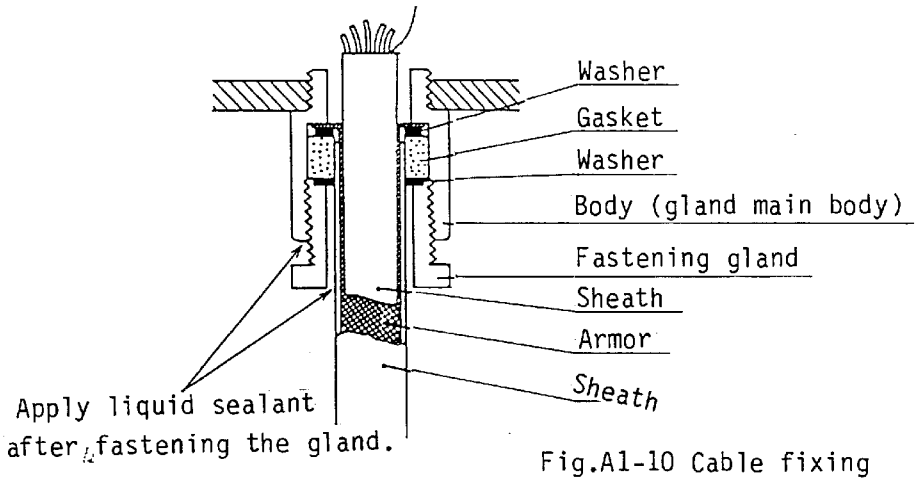


Fig.A1-10 Cable fixing

A1-3 Display unit/Speaker/Inverter

Display unit

The display unit should be placed for convenience of observation of the image on the CRT operation, maintenance and inspection. The installation area should be well-ventilated, free from splashing sea water, etc. and a place of minimal vibration. The display unit should be away from noise sources such as the inverter, power cable, radar antenna cable, etc.

<Mounting procedure>

(1) Loosen the two screws which fix the mounting base and remove the connectors on the rear side. Then, remove the mounting base from the main unit.

(2) Fix the mounting base on a desk, table, etc. with the four wood-screws (M8X32: supplied as installation materials) or M8 bolts and nuts.

(3) Fix the cables with the cable clamp, and make necessary wirings referring to ??????.

(4) Replace the display unit on the mounting base and fasten it with the two fixing screws.

Note: Service clearance shall be 100 mm or more at the both sides, 150 mm or more at the rear and 150 mm or more at the top.

Speaker

The approximately 1.6 m long cord is attached for the box type speaker (SP4-4). Install the speaker in a convenient place. Since the plug is attached at the end of the speaker cord, cut off the plug because of the terminal connection.

Inverter

The inverter is required for operation from the DC24V ship's mains. It shall be placed far from the display unit to avoid noise interference. Avoid places of poor ventilation and high temperatures.

A1-4 Corrosion-proof treatment

To avoid electrolytic corrosion of the mounting areas of the loop antenna and goniometer box placed outdoors, apply liquid sealant to specified parts when installed and maintained.

(1) Points to be coated

Coat the bolt fastening areas and sealing areas according to the installation procedure of the loop antenna and goniometer box (Page A1- to A1-). Since the liquid sealant has less conductivity, observe the coating instruction when applying to areas which require electric conductivity.

(2) Coating instruction

Wipe water, oil and dirt off the surface to coat, and proceed with the following procedure.

When electric conductivity is not required,

1) Insert the bolt into the washer.

2) Coat the whole threaded area of the bolt with liquid sealant and then fasten the bolt.

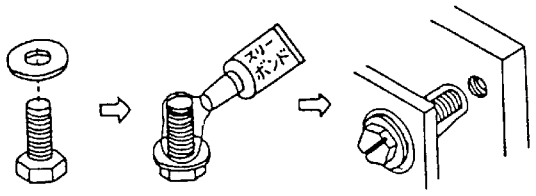


Fig.A1-11

When electric conductivity is required,

1) Completely fasten the bolt.

2) To prevent water from penetrating the mating areas of the bolt and nut, coat the bolt and nut to cover them.

3) Confirm the conductivity.

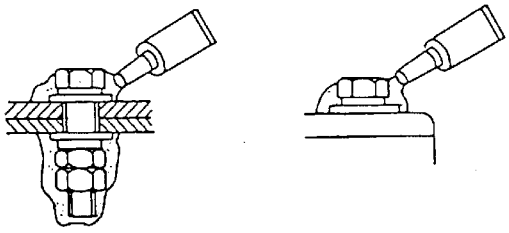


Fig.A1-12

Note: 1. When reassembling the liquid sealant coated area after disassembly, new liquid sealant may be coated over the old one.

2. When using the liquid sealant 1211, use the attached attachment nozzle.

3. After using the liquid sealant, remove the nozzle and tighten the cap for storage. The storage limit is about one year.

A1-5 Grounding

To operate the equipment with expected performances, grounding, shown below is very important.

Loop antenna

Since the looped part of the antenna is shielded to generate electromotive force from only the magnetic field, the antenna main body must be completely grounded. In case of steel ships, it is grounded through the mounting bolts and tooth-lock washers between the antenna mounting base and the flange welded to the steel mast. In case of FRP ships, the grounding can be formed to the ground terminal of the display unit through the shield and armor of the cable.

Goniometer box

The box can be grounded in the same way as the loop antenna.
In case of steel ships, the grounding is formed to the ship's body through the mounting bolts and tooth-lock washers.
In this case, electric conductivity will be formed by removing paint and rust around the bolt holes. In case of FRP ships, the grounding can be formed to the display unit through the shield and armor of the cable.

Display unit

Using solder cream, connect the copper grounding strap (0.4 x 50 x 1200) included in the installation materials to the grounding bus bar (wide grounding copper plate) soldered to the ship's body.
Connect the other end to the grounding terminal of the display unit.
In case of non-conductive ships such as FRP, attach a grounding plate (1 square meter or more) on the bottom of the ship, for example, and route a 10 cm wide copper strap to the chart room where the display unit is located.

> Particularly when the loop antenna or goniometer box is not completely grounded, double propeller image will appear.
> Be sure to use the tooth-lock washers.

A1-6 Wiring

(1) Loop antenna

The end fabricated with (crimp-on lugs) is connected to the loop antenna.
Remove the loop antenna mounting base lid and connect the cable to the respective terminals.
Two shield wires (grounding) are provided. One wire should be connected to the cable clamp hardware of the flange and the other wire to "E" terminal of the loop antenna.
Never cut nor extend these antenna cables.

(2) Goniometer box

The 10-pair multi-core cable (07S0041) is wired to the terminal boards TB1 and TB2, and the drain wire to the chassis of the goniometer. On the coax cable (07S0040), the core wire is connected to the terminal board TB3 and the outer conductor is fastened with the cable clamp. The drain wire is fastened with the cable clamp screw. On the antenna cable (07S0038), each core wire is connected to the terminal board and each shield is fastened together with the cable clamp. The drain wire is fastened to the chassis of the goniometer.

For details of the cable end fabrication, refer to Page A1-12.

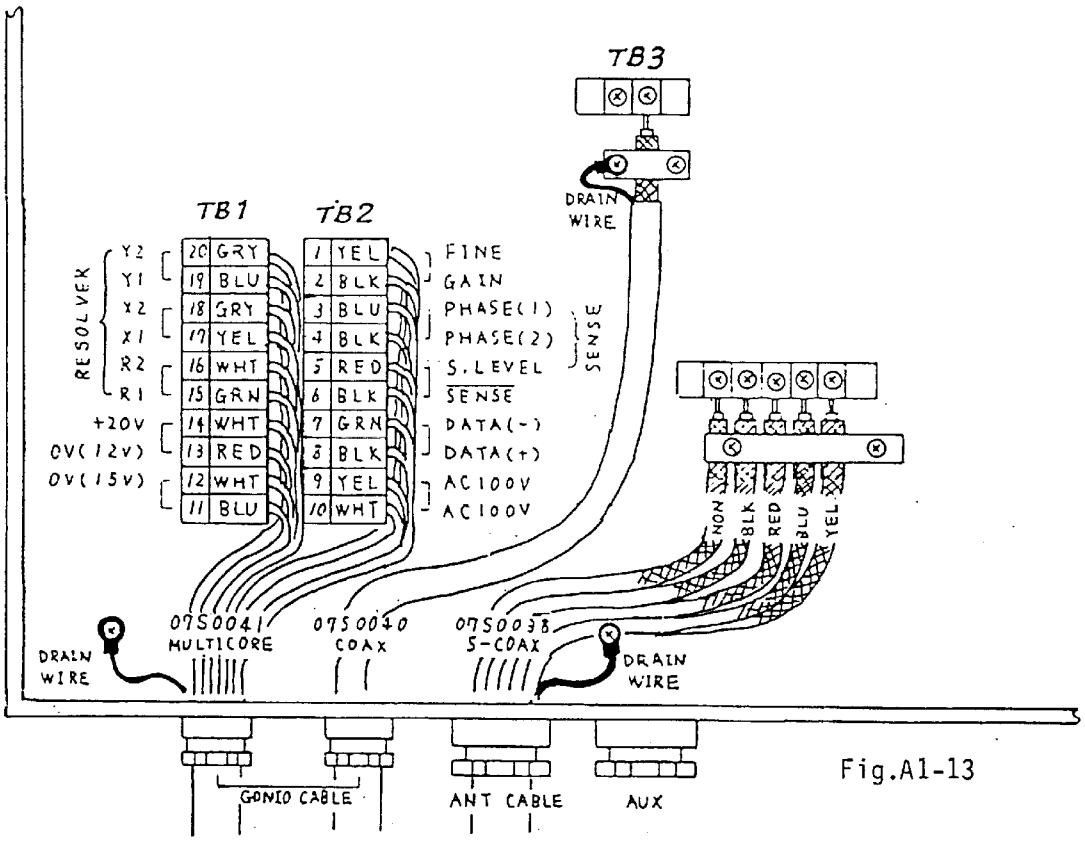
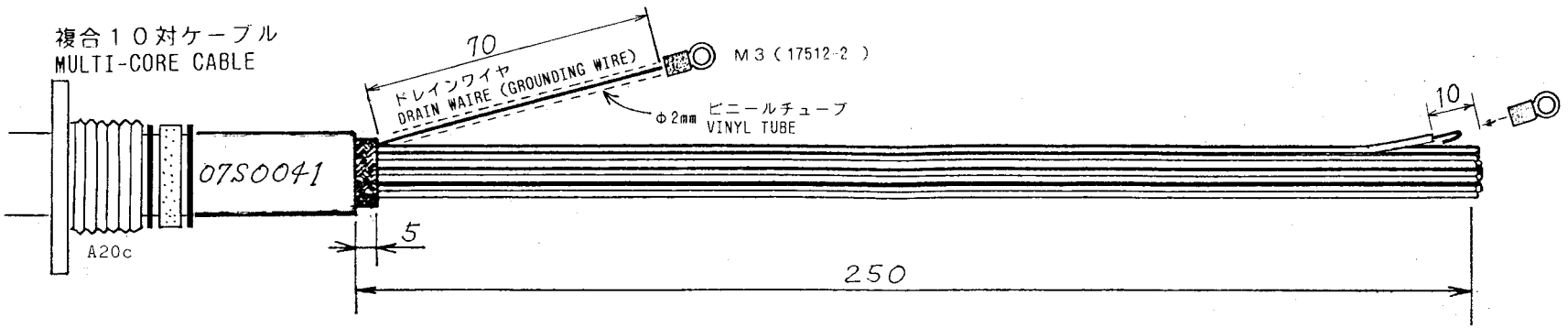


Fig.A1-13

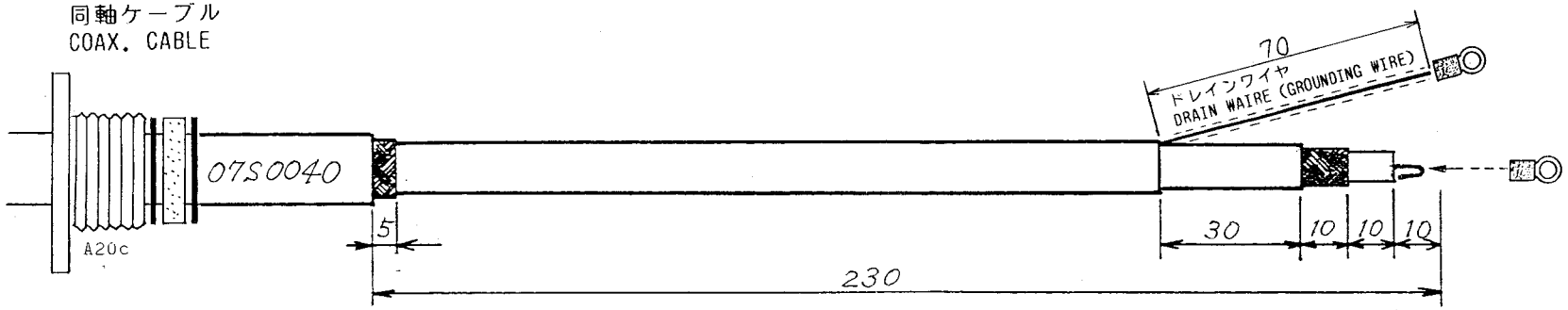
FURUNO

A1-12

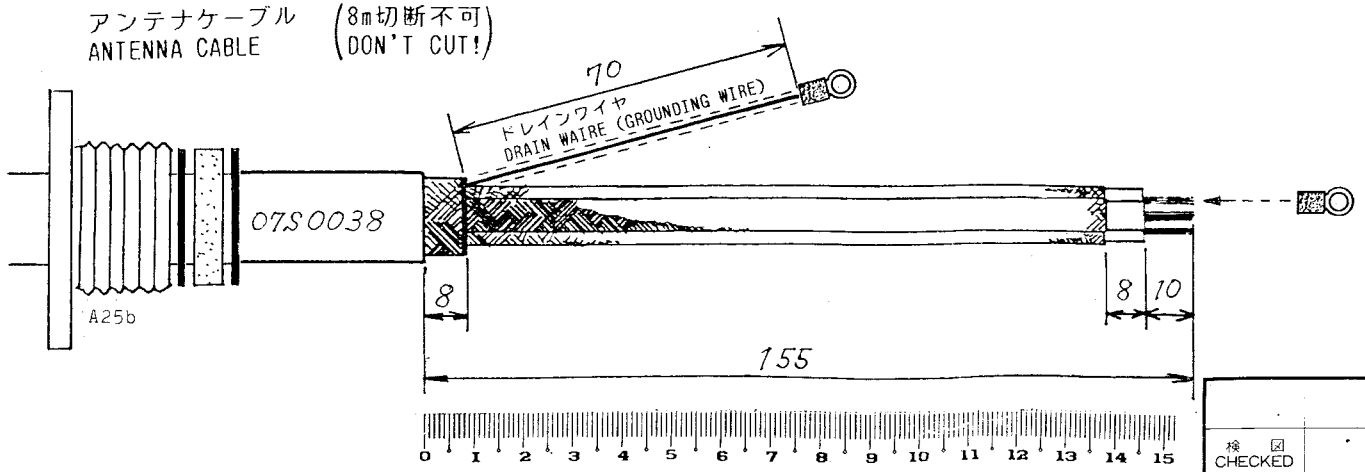
複合１０対ケーブル
MULTI-CORE CABLE



同軸ケーブル
COAX. CABLE



アンテナケーブル　（8m切断不可
ANTENNA CABLE　（DON'T CUT!）



検図 CHECKED	名称 TITLE: ゴニオメーターボックス側 ケーブル処理 CABLE FABRICATION AT GONIO METER BOX
製図 DRAWN	図番 DWG. NO.

FURUNO ELECTRIC CO., LTD.

(3) Display unit

The 10-pair, multi-core cable is routed to the terminal boards TB1 and TB2. On the coax cable, the core wire is routed to the terminal board TB3 and the outer conductor is fastened with the cable clamp. The respective drain wires are fastened on the grounding plate with the screw.
Remove the paint on the armor of cables at the cable clamp and fasten them with the cable clamp at the cable entry.

10-pair multi-core cable (07S0041)

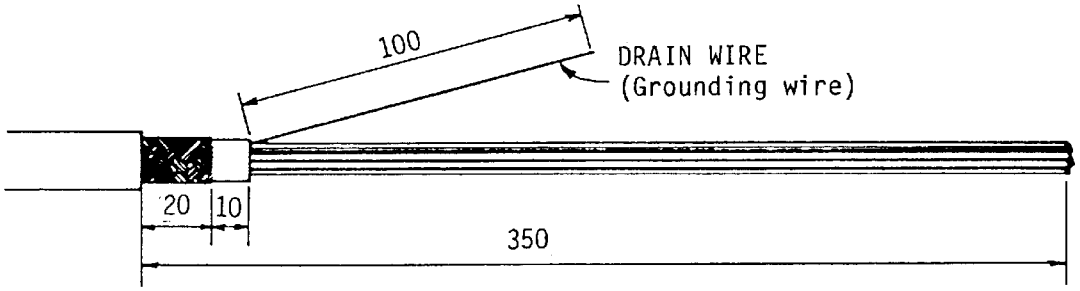


Fig. A1-14a

Coax cable (07S0040)

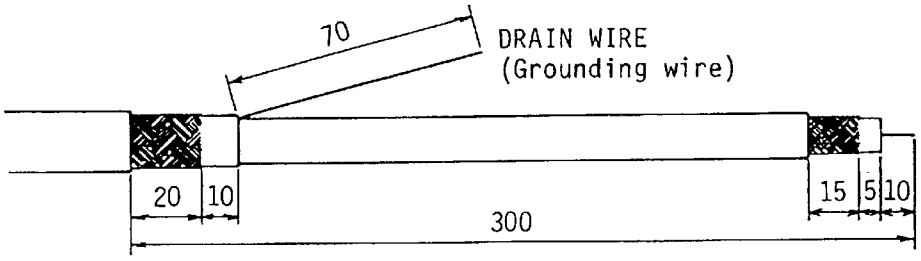


Fig. A1-14b

Cable end fabrication

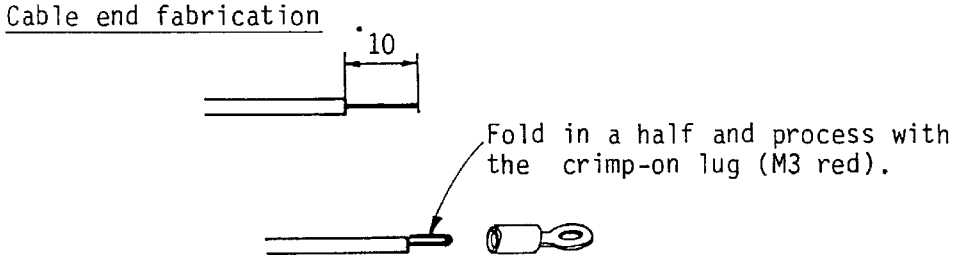
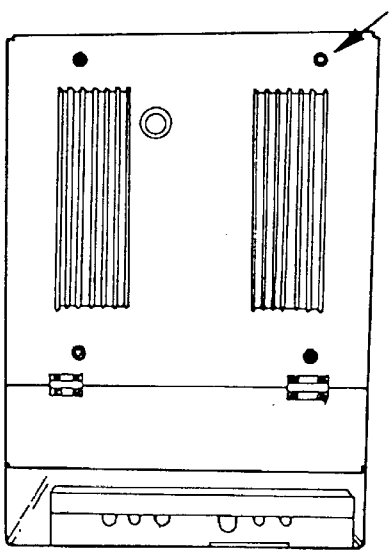


Fig. A1-14c

Each drain wire is covered with a vinyl tube φ2/) and processed with the crimp-on lug (M4 red).

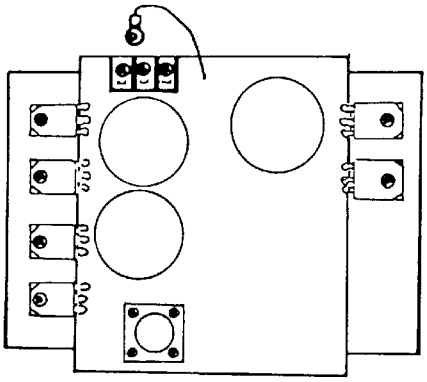
Appendix-2 SET-UP

A2-1 Power source voltage inspection/change



Remove the four screws on the rear of the display unit, and the rear panel will be opened.

Fig.A2-1



The power supply circuit board (07P2125) is located on the rear panel. Confirm that the jumper wire on the terminal board of the circuit board is connected to the appropriate power source voltage terminal. (The voltage is available in 100, 110 and 220V. Since a tolerance of ± 20% is allowed, connect to the 110V terminal for 115V.) The fuse need not be replaced.

Fig.A2-2

A2-2 Sensitivity inspection

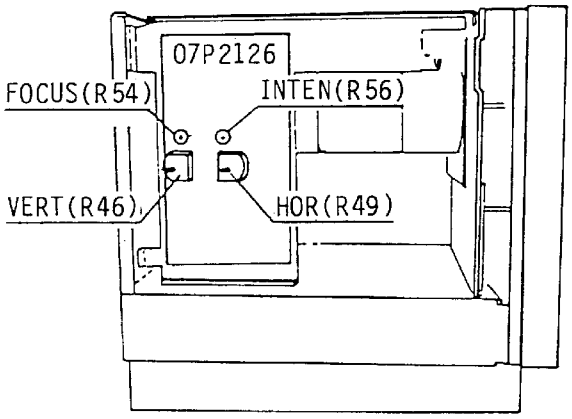
(1) Turn the (FINE) control to check whether the antenna fine tuning is effective or not. (With AGC turned off, confirm that the peak output point exists for the set noise under no receiving signal.)

(2) Check of sensitivity by receiving reference radio signal.
Record the normal receiving condition of a typical radio station at a known location such as a beacon station 200 to 300 miles away. Check whether the propeller pattern and voice are sufficient or not by comparing with the recorded data.

(3) External noise level should be negligible.

A2-3 Video circuit adjustment

When the brightness becomes insufficient or the center point deviates depending on the environmental conditions, remove the cover from the display unit and correct the irregularity with the potentiometers on the pattern VIDEO circuit board (07P2126). Use the propeller pattern for adjustment.

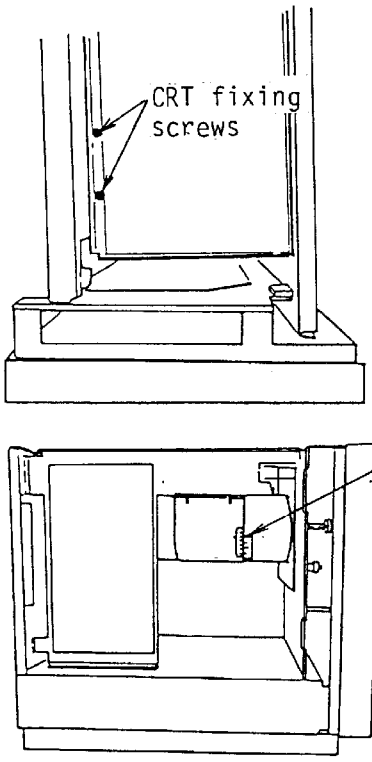


Adjustment item		Potentiometer
Brightness		INTEN(R56)
Focus		FOCUS(R54)
Center point	Vertical	VERT(R46)
	Horizontal	HOR(R49)

Fig. A2-3

A2-4 Bow direction calibration

Place a test transmitter, radio buoy, etc. (2MHz band) just in the bow direction, and check whether the propeller pattern indicates 0 degree or not. For the deviated indication, correct the error according to the following procedure.
(If the deviation exceeds 5 degrees, first correct the mounting angle of the loop antenna.)



1) Remove the cover, and the SENSE circuit board will be visible on the top. The CRT fixing screws are located on both sides.

2) Loosen the screws and rotate the CRT in reference to the scale seal.

3) Retighten the fixing screws.

Fig.A2-4

A2-5 Sense adjustment

The Model FD-160 Direction Finder covers a frequency range of 1.5 to 18 MHz, which is used for direction finding, in 4 bands, and each band is divided into two parts as standard for optimum sense adjustment. When this division is not satisfactory (frequencies with proper and improper senses are mixed in the same band), it can be further divided. The optimum "sense adjustment values" for each divided part can be stored in the memory and they can be read out according to the set frequency.
The outline of this function is described as follows.

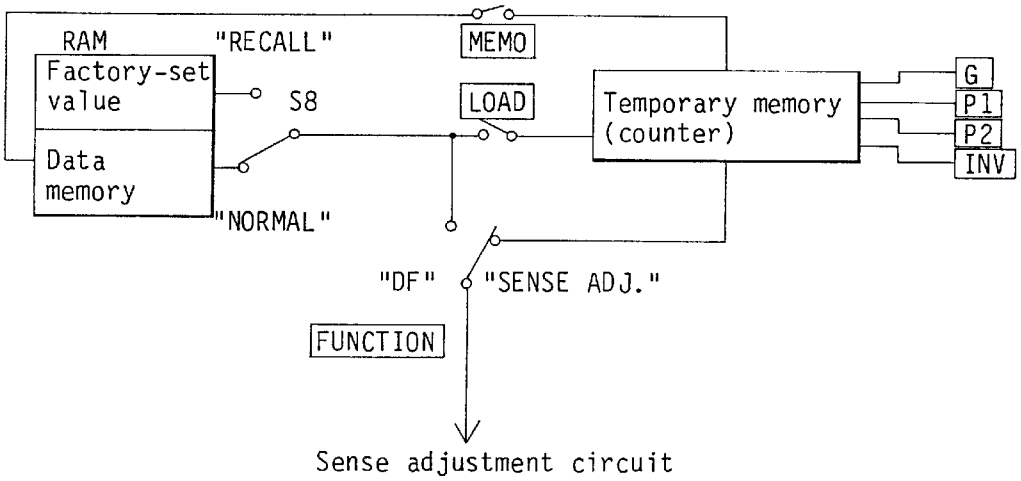
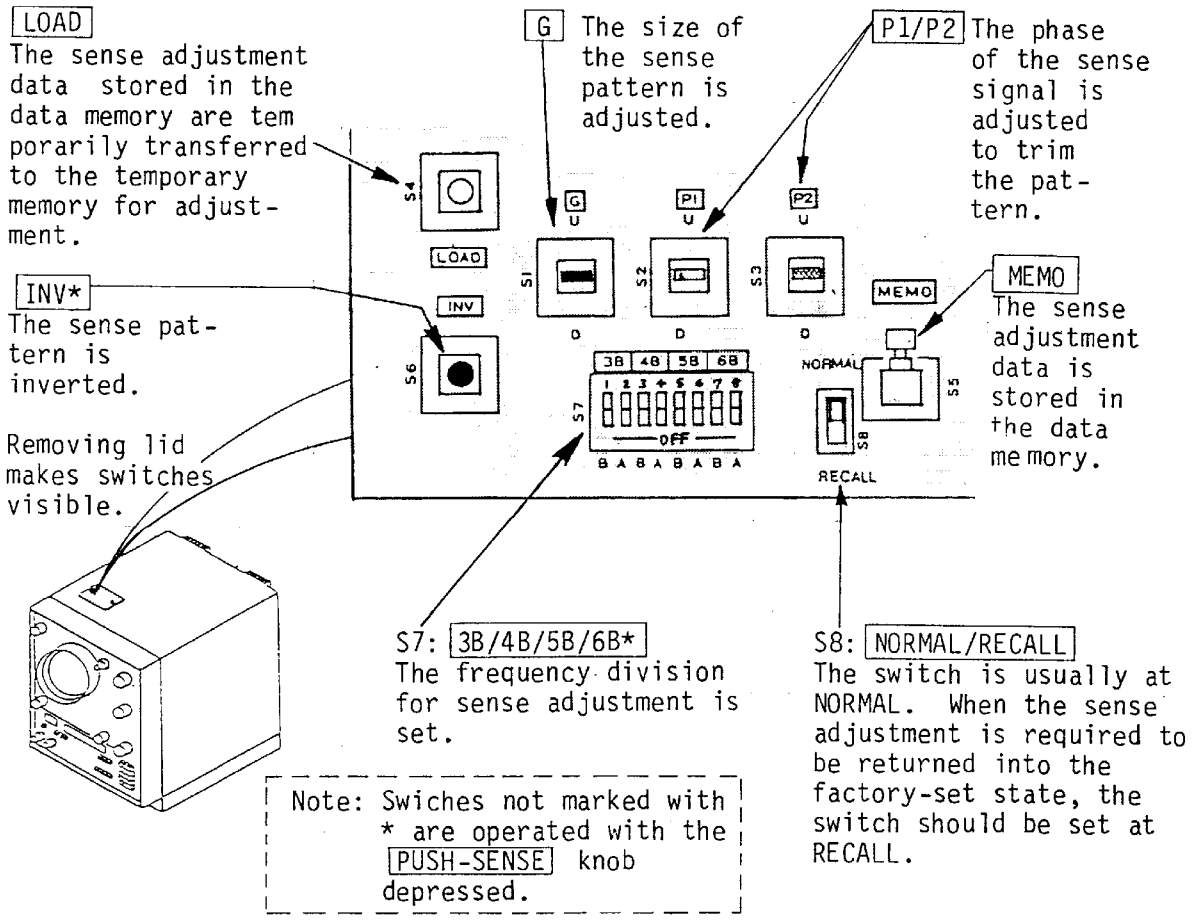


Fig.A2-5 Outline diagram

In a part of RAM, standard sense adjustment data are set at the factory. These data are also stored in the data memory.
For adjustment, first push the [LOAD] button with the [SENSE ADJ.] knob depressed, and the factory-set values in the data memory are transferred to the temporary memory. (In this operation, the [PUSH-SENSE] knob is not necessarily depressed but the data transfer can be confirmed by observing the sense pattern with the [PUSH-SENSE] knob. The data in the temporary memory can be changed when the sense adjustment is carried out with the [G] (gain adjustment), [P1] (phase 1 adjustment) and [P2] (phase 2 adjustment) levers.
The adjusted data is stored in the data memory by pushing the MEMO button with the [PUSH-SENSE] knob depressed. To confirm that the data has been transferred into the data memory, push the [PUSH-SENSE] knob and turn the [FUNCTION] switch between "DF" and "SENSE ADJ.". If the same sense patterns are displayed in both positions, the data is properly transferred.
If the proper point is missed during the sense adjustment, the factory-set data can be recalled. For recall, turn the S8 switch to "RECALL" and push the [LOAD] button with the [PUSH-SENSE] knob depressed.

For actual adjustment at installation, bring the ship off the shore and use the signal of the station which is in the previously known direction. When the ship is in the port, roughly check the conditions of the sense pattern on all frequencies to be used; though the antennas of other ships and surrounding structures disturb the proper adjustment.

A2-5-1 Function of switches



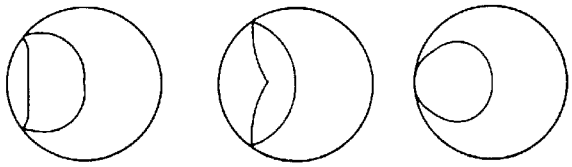
A2-5-2 Adjusting procedure for sense pattern

(1) Remove the lid on the top of the main unit.

(2) Compare the setting of the frequency division switches S7 with the frequency division table on the rear of the lid, and check the switch setting.
(For details of the S7 setting, refer to "8-5-3 Frequency division setting".)

(3) Check whether the sense patterns are proper or not by receiving the frequencies one by one in each frequency division. Stand the bow to the station (coast station, radio broadcast station, fellow ship, etc.), the direction of which is previously known, and adjust to gain the optimum propeller pattern referring to "6. Direction Finding Operation". It is the best way to check the sense pattern with the fellow ship contacted.

Sense pattern in the optimum sense adjustment (Ideal pattern)



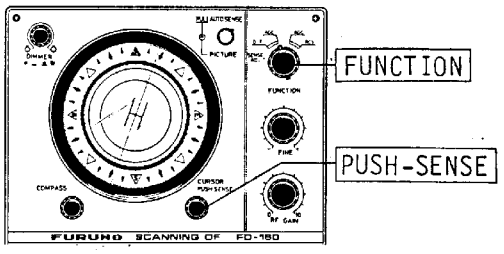
Excellent Excellent Good

(4) When the proper sense pattern is not gained over the entire range of frequencies in a frequency division, carry out the sense adjustment to gain relatively good sense pattern for any frequency in a frequency division.

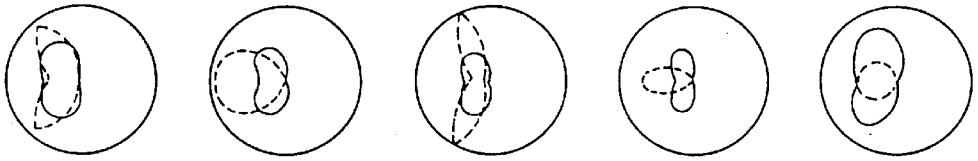
1) Set the [FUNCTION] switch at the [SENSE ADJ.]

2) Push the [LOAD] button with the [PUSH-SENSE] knob depressed.

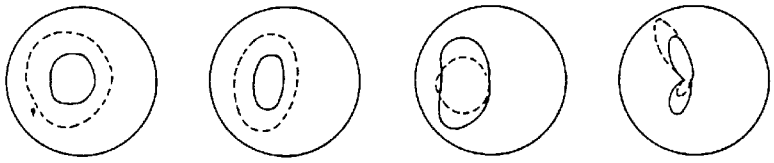
3) Trim the sense pattern by alternately pushing the [G], [P1] and [P2] levers with the [PUSH-SENSE] knob depressed.



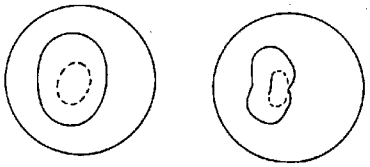
- Sense pattern variation when adjusted for better phase of sense signal (Solid line ⟶ Dotted line)



- Sense pattern variation when adjusted for worse phase
  (Solid line ⟶ Dotted line)



- Sense pattern variation when better or worse phase is not judged Solid line ⟶ Dotted line
  (To be judged with the [G] lever operated.)



4) Check whether the sense pattern is inverted or not.
   Use the [INV] switch to correct.

Note 1. For BAND-1/BAND-2 (200kHz to 1.5MHz)), [P1] and [P2] are not effective, use [G] only for sense adjustment.
For BAND-3 (1.5 to 3.5MHz), [P1] is not effective, use [G] and [P2] for sense adjustment.

2. When the lever [G], [P1], [P2], etc. is continuously pushed, a high-pitch sound will be heard. This indicates that the setting has reached the limit of its adjusting range.

(5) Store the sense adjustment data in the memory.

Push the [MEMO] button with the [PUSH-SENSE] knob depressed.

- Confirm that the sense data is completely memorized.
  The sense data is properly memorized if the same pattern appears when the [FUNCTION] switch is alternately turned to "SENSE ADJ." and "DF" with the [PUSH-SENSE] knob depressed.

Check other frequencies in the same frequency division. When relatively good patterns are gained over the entire range of frequencies in the same frequency division, proceed to the next frequency division. When a certain frequency shows poor sense in a frequency division, refer to "A2-5-3 Frequencies division setting".

Reference: RECALL function

The recall function is used to restore the setting into the factory-set state when the sense pattern becomes worse after adjustment.

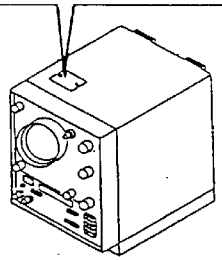
Operation procedure

1) Turn the [FUNCTION] switch from "DF" to "SENSE ADJ.".
2) Turn the S8 switch from [NORMAL] to [RECALL].
3) Select a frequency in the affected frequency division.
4) Push ths [LOAD] button with the [PUSH-SENSE] knob depressed.
5) Return the S8 switch from [RECALL] to [NORMAL].
6) Push the [MEMORY] button with the [PUSH-SENSE] knob depressed.

A2-5-3 Frequency division setting

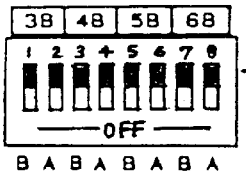
The Model FD-160 Direction Finder has a capability to divide the frequency range for sense adjustment more finely, to a maximum of 29 frequency divisions.
When delivered from the factory, the equipment is set at the minimum frequency division (No. 3 thru 6 bands are respectively divided into two parts. This setting allows easy adjustment unless a difficulty happens to the sense. However, due to the surrounding conditions of the loop antenna, poor sense patterns can be occasionally gained in only some part of frequencies in a frequency division. In this case, it is better for easy sense adjustment to make the frequency range narrower to increase the number of frequency divisions.

The frequency division table is attached on the rear of the lid.



BAND	S7 A	S7 B	センス調整周波数区分 FREQUENCY DIVISION FOR SENSE ADJUSTMENT									
3	ON	ON	1.5-2.5	2.5-3.5								
	ON	OFF	1.5-2.2	2.2-2.5	2.5-3	3-3.5						
	OFF	OFF	1.5-1.8	1.8-2.2	2.2-2.5	2.5-3	3-3.5					
4	ON	ON	3.5-5	5-7								
	ON	OFF	3.5-4	4-5	5-6	6-7						
	OFF	OFF	3.5-4	4-4.5	4.5-5	5-5.5	5.5-6	6-6.5	6.5-7			
5	ON	ON	7-9	9-12								
	ON	OFF	7-8	8-9	9-11	11-12						
	OFF	OFF	7-7.5	7.5-8	8-8.5	8.5-9	9-10	10-11	11-12			
6	ON	ON	12-14	14-18								
	ON	OFF	12-13	13-14	14-16	16-18						
	OFF	OFF	12-12.5	12.5-13	13-13.5	13.5-14	14-15	15-16	16-17	17-18		

BAND-1 0.2-0.54 BAND-2 0.54-1.5 (MHz)

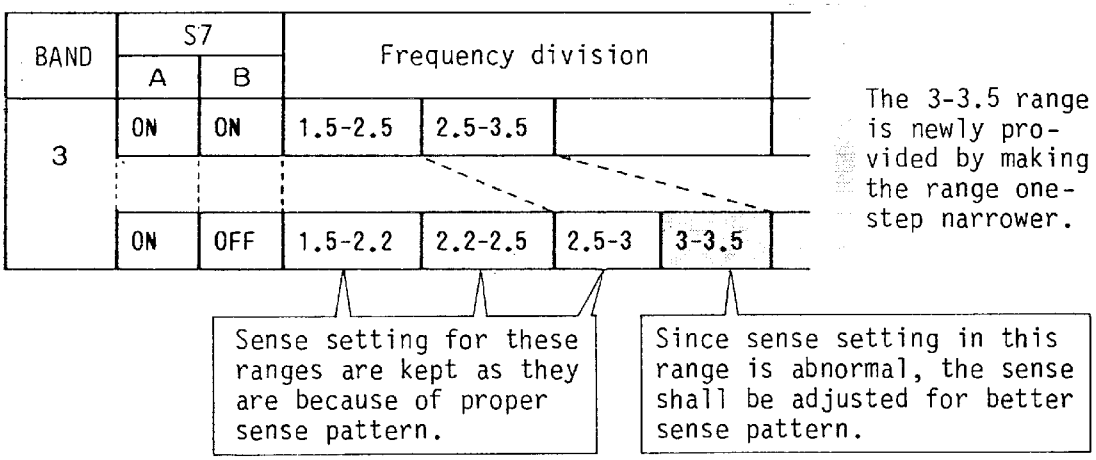


S7: [3B/4B/5B/6B]
The A and B switches for each of bands 3 to 6 are turned on/off to select the frequency division as shown in the table.

Example: Band 3 (1.5 thru 3.5MHz)

BAND	S7 A	S7 B	センス調整周波数区分 FREQUENCY DIVISION FOR SENSE ADJUSTMENT					
3	ON	ON	1.5-2.5	2.5-3.5				←Minimum frequency division
	ON	OFF	1.5-2.2	2.2-2.5	2.5-3	3-3.5		←Newly set frequency division
	OFF	OFF	1.5-1.8	1.8-2.2	2.2-2.5	2.5-3	3-3.5	

The sense pattern is not good when the 3.2MHz signal is received in the minimum frequency division (frequency range of 2.5 to 3.5MHz). In this case, make the frequency range narrower because of the following reasons.



- Setting procedure

1) Transfer the proper sense adjustment data in the "1.5 - 2.5"(MHz) into the temporary memory.

   1) Confirm that the A and B switches of S7 are "ON".
   2) Turn the [FUNCTION] switch to "SENSE ADJ.".
   3) Select a frequency among the "1.5-2.5"(MHz).
   4) Push the [LOAD] button with the [PUSH-SENSE] knob depressed.

2) Make the frequency range one-step narrower. Transfer the "1.5 - 2.5"(MHz) data in the temporary memory into the "1.5 - 2.2" and "2.2 - 2.5"(MHz).

   1) Turn off the B switch with the A switch kept on.
   2) Select a frequency in "1.5 - 2.2"(MHz).
   3) Push the [MEMO] button with the [PUSH-SENSE] knob depressed.
   4) Select a frequency in "2.2 - 2.5"(MHz).
   5) Push the [MEMO] button with the [PUSH-SENSE] knob depressed.

3) Repeat the same procedure for a frequency range of "2.5-3"(MHz) to store the data into the memory.

4) Select a frequency in "3 - 3.5"(MHz) and pattern data. Select a frequency in "3 - 3.5"(MHz), and adjust the sense pattern by referring to "A2-5-2 Adjusting procedure for sense pattern". Then, store the data into the data memory.

A2-6 How to make calibration curves

When provided with the calibration curve, the direction finder is able to find a highly accurate direction.
Depending on surrounding conditions, the direction finder which can receive high frequencies up to 18MHz sometimes shows a 10 degree or more direction error even in the bow. After the equipment is installed, the calibration curve is generally taken for typical/important frequencies in each band.
When new frequencies are added to use later, or when the structure around the loop antenna varies, the correction curve shall be compensated. However, for collection of error data, a strict method using the dumb card, etc. is not necessary. It is usual to use a simple method of turning the ship in a small circle while receiving the signal from the fellow ship of which the position (direction) is observed on the radar screen.

Simple error measurement procedure (summary)

1) Keep your ship 1 mile away from your fellow ship.
2) Observe your fellow ship on the radar screen.
3) Continuously contact your fellow ship by radiotelephone.
4) First, place your fellow ship in the bow direction of your ship and confirm that the sense pattern is proper.
   If the sense pattern is not proper, read just the sense pattern.
5) Measure the direction on the equipment. Enter the reading on the "calibration record" paper supplied.
6) Slowly turn your ship in a small circle.
7) The radar operator informs the direction finder operator of the direction of your fellow ship in steps of 10 degrees by voice.
8) Corresponding to every voice, the direction finder operator enters the reading on the "calibration record" paper.
9) After one turn, calculate the correction values (correct direction minus measured direction), and confirm that the correction values are not abnormally large.
   It is best to draw the approximate calibration curve at this time.
10) Select the next frequency. Repeat the procedure from Step 4 to Step 9).
11) When the error measurements are completed in all necessary frequencies, draw the calibration curves.
    Several curves are usually drawn on one paper.

FURUNO

無線方位測定機修正記録
DIRECTION FINDER CALIBRATION RECORD

型　式 Model _____　周波数 Frequency _____ kHz　測定者 Measured By _____

製造番号 Serial No. _____　デリック Derrick _____　場　所 Place _____

船　名 Ship's Name _____　吃　水 Draft FORE: m, AFT: m　日　時 Date _____

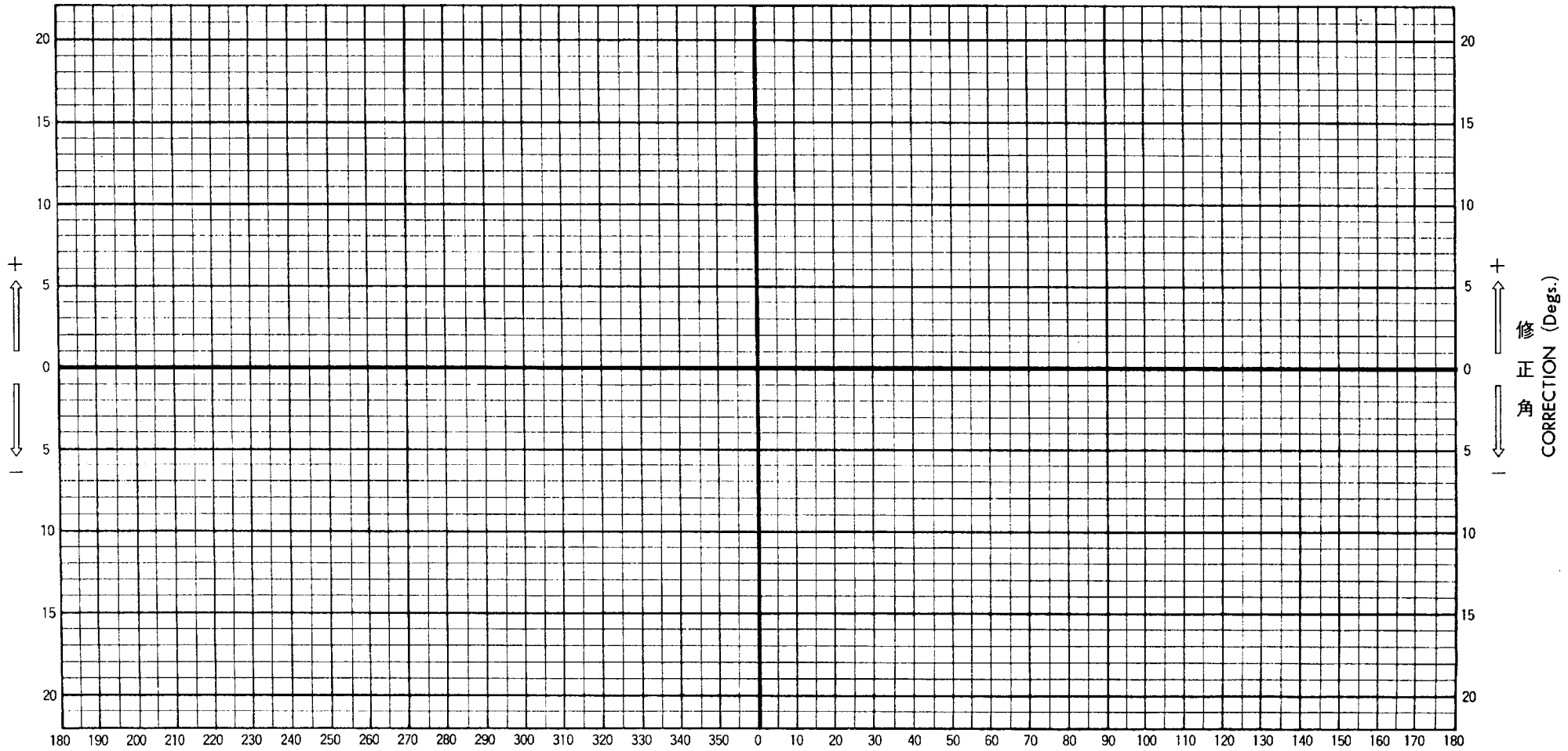
所　属 Owner _____　アンテナ Antenna MAIN : OFF, EMG : OFF　立会者 Observer _____

時計方向回り CLOCKWISE						反時計方向回り COUNTERCLOCKWISE					
真　値(A) TRANSIT BEARING	測定値(B) D.F. READING	修正角 COR. (A−B)	真　値(A) TRANSIT BEARING	測定値(B) D.F. READING	修正角 COR. (A−B)	真　値(A) TRANSIT BEARING	測定値(B) D.F. READING	修正角 COR. (A−B)	真　値(A) TRANSIT BEARING	測定値(B) D.F. READING	修正角 COR. (A−B)
0			0			360			360		
10			10			350			350		
20			20			340			340		
30			30			330			330		
40			40			320			320		
50			50			310			310		
60			60			300			300		
70			70			290			290		
80			80			280			280		
90			90			270			270		
100			100			260			260		
110			110			250			250		
120			120			240			240		
130			130			230			230		
140			140			220			220		
150			150			210			210		
160			160			200			200		
170			170			190			190		
180			180			180			180		
190			190			170			170		
200			200			160			160		
210			210			150			150		
220			220			140			140		
230			230			130			130		
240			240			120			120		
250			250			110			110		
260			260			100			100		
270			270			90			90		
280			280			80			80		
290			290			70			70		
300			300			60			60		
310			310			50			50		
320			320			40			40		
330			330			30			30		
340			340			20			20		
350			350			10			10		

FURUNO

無線方位測定機修正曲線
DIRECTION FINDER CALIBRATION CURVE

型　式 Model		測定周波数 Frequency	kHz	測定者 Measured By	
製造番号 Serial No.		デリック Derrick		場　所 Place	
船　名 Ship's Name		吃　水 Draft	FORE:　m, AFT:　m	日　時 Date	
所　属 Owner		無線アンテナ Radio Ant	MAIN : OFF, EMG : OFF	立会者 Observer	



A2-11

FD-160 DIRECTION FINDER

1.	Indication System	75mm dia. CRT, electrostatic deflection
2.	Receiving Mode	A1A, A2A, H2A, A3E, H3E, J3E
3.	Receiver Frequency Range	100Hz to 29.9999MHZ, 100Hz step
4.	DF Frequency Range	200kHz to 18MHz
5.	Receiving System	PLL synthesizer, triple conversion superheterodyne
6.	Intermediate Frequency	1st 45.454MHz 2nd 455kHz 3rd 175kHz
7.	Selectivity	More than 2kHz at -6dB, Within 10kHz at -66dB
8.	Minimum Field Strength for DF at ±15° Accuracy	MF(410kHz) :15uV/m or more IF(2182kHz) : 8uV/m or more
9.	Bearing Accuracy	±1° for input level of 1mV/m at 410kHz
10.	Sense Determination	Automatic or manual
11.	Audio Output	Rated 5 watts (into 8 ohm load)
12.	Antenna System	85cm dia. fixed cross loop with 2m vertical sense antenna
13.	Gyro Repeater	Optionally supplied Type:
14.	Additional Functions	
	1) Channel Memory	200 CH max. (freq./emission mode stored)
	2) Channel Scan	Up to 20 groups (10 CH for each group)
	3) Frequency Scan	Selective in 100Hz steps min.
	4) Scaning Interval & Stop Time	1 to 9999 seconds
	5) Scan Stop	Automatic or Manual
15.	Environmental Conditions	Temperature Range: -10°C to +50°C Relative Humidity: 95% at +35°C
16.	Dimensions and Weight	Display Unit: 280(W) x 373(H) x 430(D)mm approx. 17kg Goniometer Box: 340(W) x 336(H) x 170(D)mm approx. 13kg Loop Antenna: Max. height 2243mm, 850mm dia. approx. 8.5kg
17.	Coating Color	2.5GY 5/1.5 Specified (Main Unit):
18.	Power Supply & Power Consumption	AC100/110/220V(±20%), 1Ø, 50/60Hz, 70VA or DC24V (with extra inverter)

Complete set

No.	Name	Type	Weight (kg)	Q'ty	Remarks
1	Display Unit	DI-160	17	1	
2	Loop Antenna	AL-85	7.5	1	
3	Sense Antenna	W-2	0.3	1	
4	Gonio Box	DG-160	13	1	
5	Accessories			1 Set	
6	Documents			1 Set	
7	Installation Materials			1 Set	
8	Spare Parts			1 Set	
9	Static Inverter	TR-2407	8.5	1	For 24Vdc Mains (Option)

Accessories

No.	Name	Descriptions	Code No.	Q'ty	Remarks
1	Speaker	SP-4-4	000-580-501	1	
2	Card Case	A5	000-831-568	1	Sense Adj. Procedure
3	Plastic Cover	07-001-0002	000-879-631	1	

Spare Parts

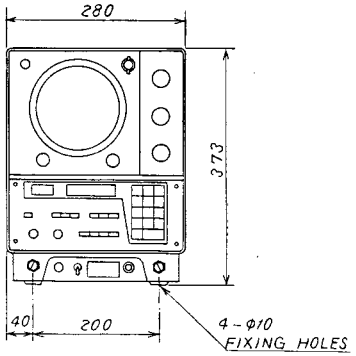
No.	Name	Type	Code No.	Q'ty	Remarks
1	Lamp	P-12 50mA	000-540-156	4	
2	Fuse	FGBO-A 2A AC125V	000-549-062	2	
	Spare Parts Box		000-831-610	1	For F-710

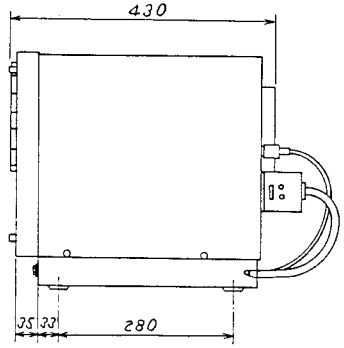
Installation Materials

No.	Name	Descriptions	Code No.	Q'ty	Remarks
1	Crimp-on Lug	FV1.25-M3	000-538-110	35	Display Unit
2	Crimp-on Lug	FV1.25-M4	000-536-715	2	
3	Woodscrew	8.0x32 C2700W	000-861-731	4	
4	Woodscrew	3.1x13 C2700W	000-861-746	46	
5	Vinyl Tube	ϕ2mm *1m*	000-568-006	1	
6	Metal Band	0.8x15x1200	000-570-105	2	
7	Copper Strap	WEA-1004-0	500-310-040	1	
8	Connector	M-P-7	000-500-512	1	
9	Hex. Bolt	M10x45 SUS304	000-862-176	4	Gonio Box
10	Hex. Nut	M10 SUS304	000-863-111	8	
11	Flat Washer	M10 SUS304	000-864-131	8	
12	Spring Washer	M10 SUS304	000-864-261	4	
13	Toothed Lock Washer	M10 SK-5 MFNI2	000-864-540	8	
14	Crimp-on Lug	FV1.25-M3	000-538-110	25	
15	Vinyl Tube	ϕ2mm *1m*	000-568-006	1	
16	Hex. Bolt	M10x45 SUS304	000-862-176	4	Loop Antenna
17	Hex. Nut	M10 SUS304	000-863-111	8	
18	Flat Washer	M10 SUS304	000-864-131	8	
19	Spring Washer	M10 SUS304	000-864-261	4	
20	Toothed Lock Washer	M10 SK-5 MFNI2	000-864-540	8	

21	Pan Head Screw	M4x12 C2700W	000-861-127	2	Loop Antenna
22	Toothed Lock Washer	M4 SK-5 MFNI2	000-864-535	2	
23	Cable Fixing Plate(2)	FDA-18292-3	730-111-123	1	
24	Adhesive	1211 50g	000-854-118	1	
25	Flange(1)	FDA-18255	730-111-024	1	
26	Loop Antenna Fixing Gasket	FDA-18261	760-111-011	1	
27	Multi-core Cable	07S0041		1	
28	Coax. Cable	ECX-5C-2V		1	
29	Antenna Cable Assy.	S07-1-8(7P)	007-284-590	1	

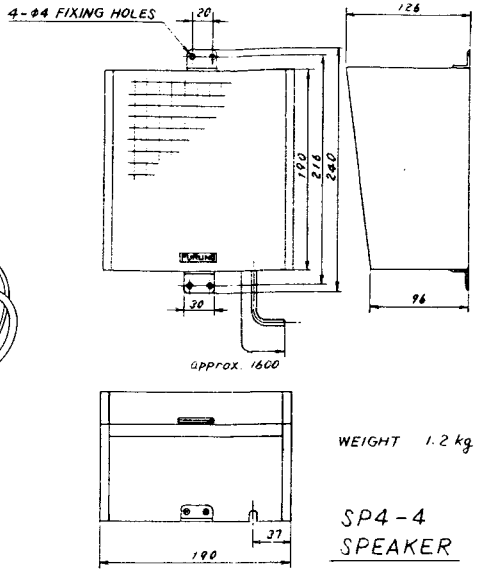
FURUNO





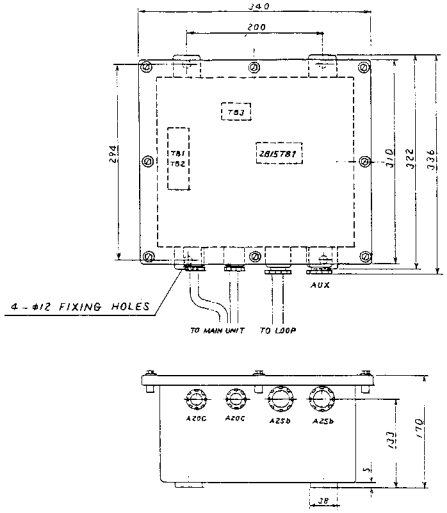
DI-160
DISPLAY UNIT

WEIGHT 17.0kg



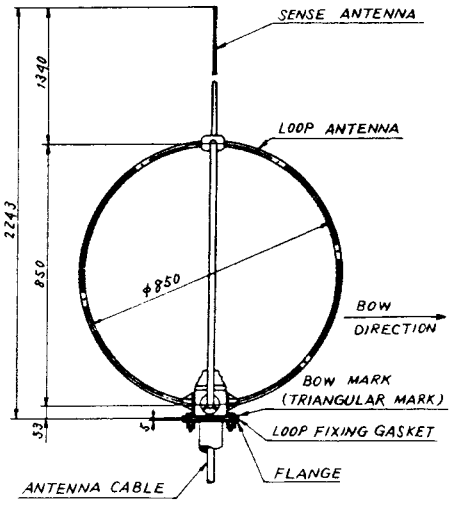
WEIGHT 1.2 kg

SP4-4
SPEAKER



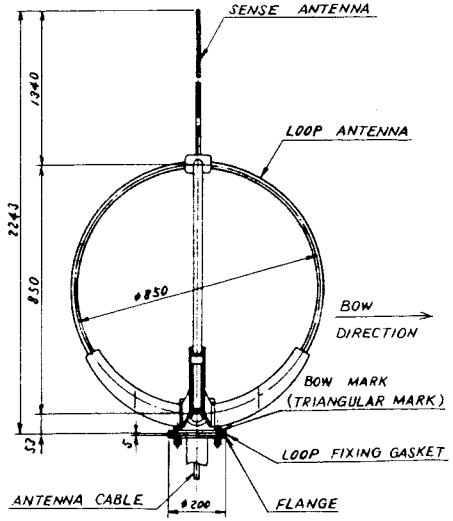
WEIGHT 13.0 kg

DG-160
GONIOMETER BOX



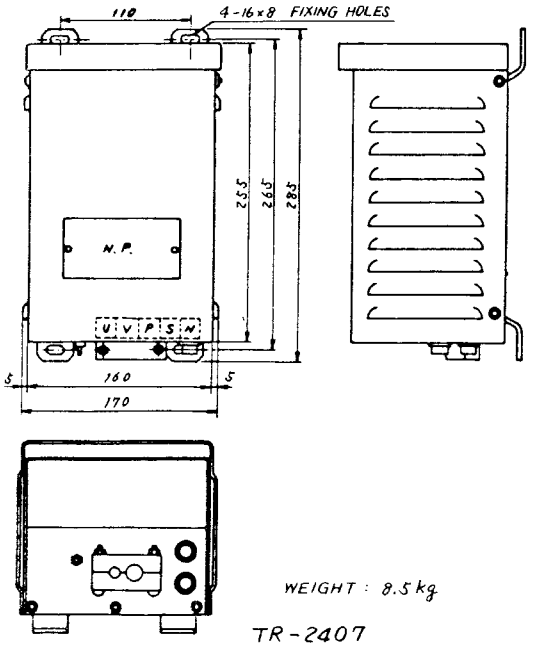
WEIGHT : 8.5 kg

AL-85
LOOP ANTENNA AND SENSE ANTENNA



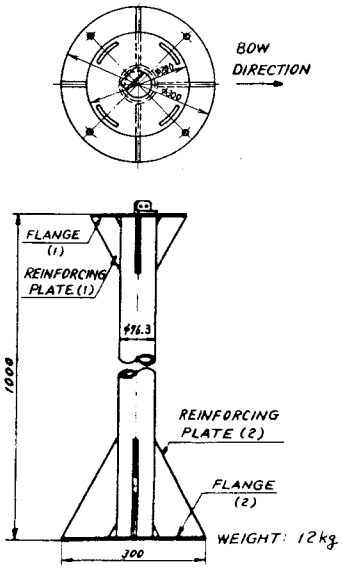
WEIGH : 12.5 kg

AL-85C
REINFORCED LOOP ANTENNA AND SENSE ANTENNA



WEIGHT : 8.5 kg

TR-2407
INVERTER

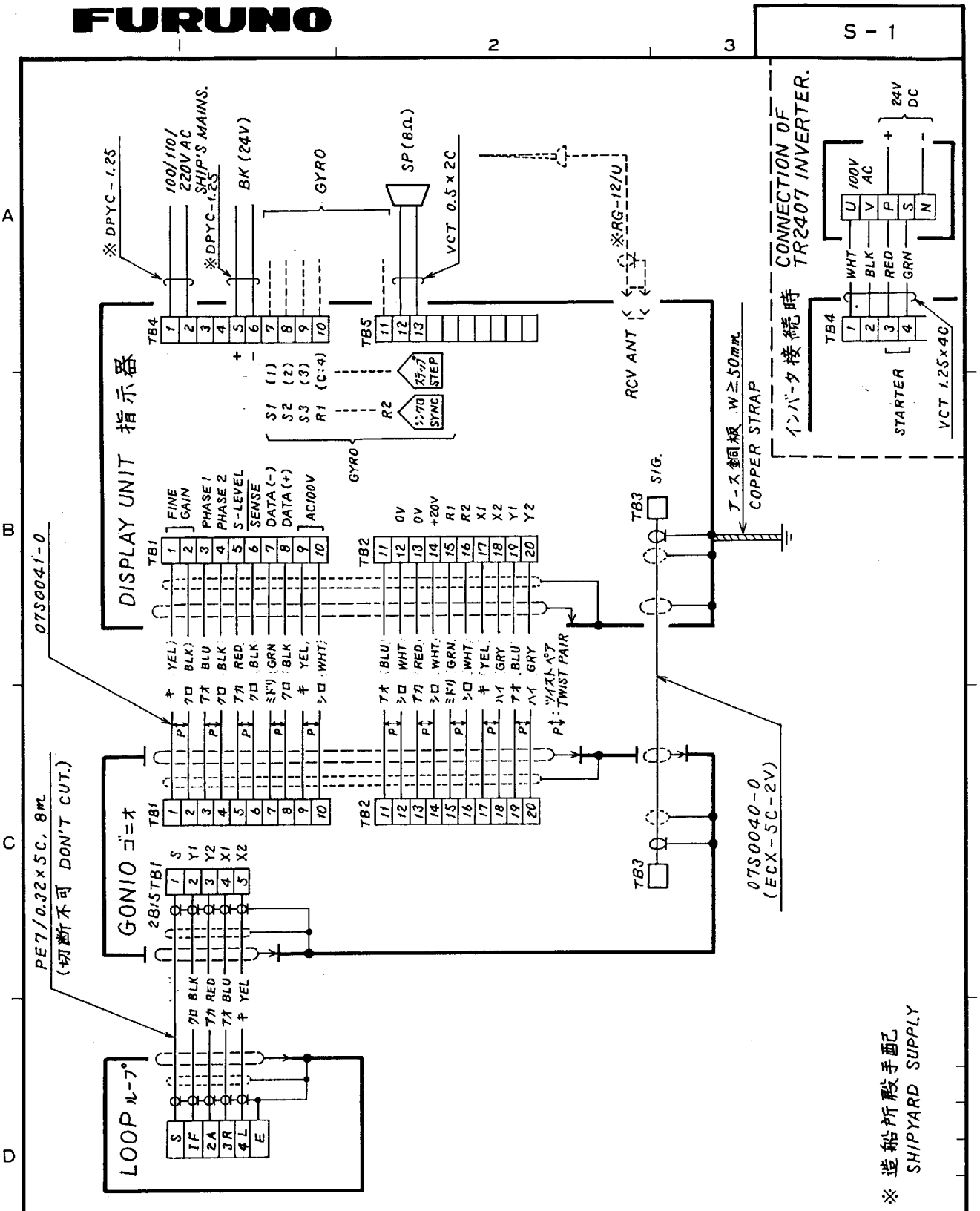


WEIGHT: 12kg

FDA-18253
ANTENNA STANCHON

FURUNO

S - 1



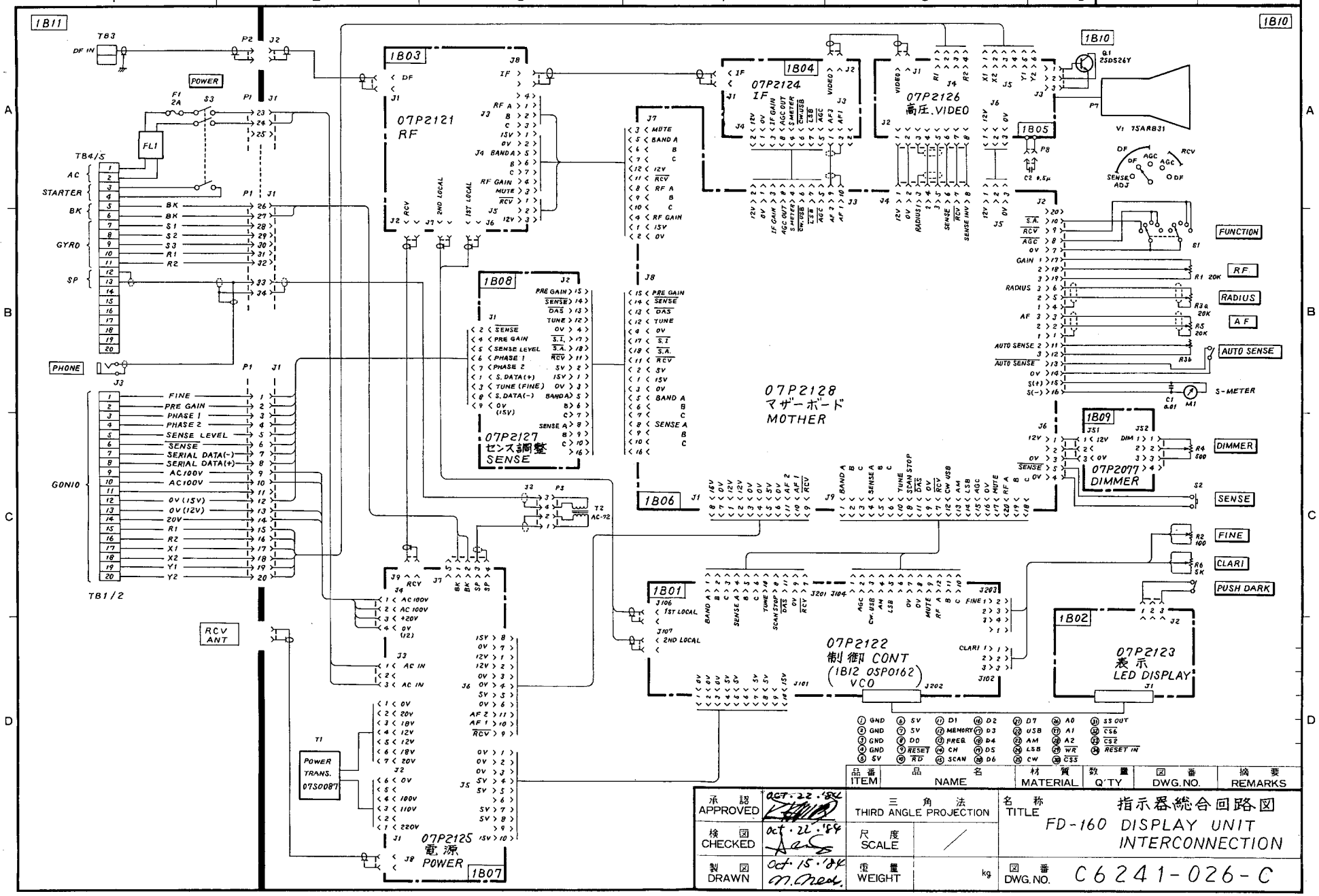
品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS

承認 APPROVED	Sep.19.'84	三角法 THIRD ANGLE PROJECTION	名称 TITLE 相互結線図 INTERCONNECTION DIAGRAM 無線方位測定機 DIRECTION FINDER FD-160
検図 CHECKED	Aug.31.'84	尺度 SCALE /	
製図 DRAWN	Aug.31.'84	重量 WEIGHT kg	図番 DWG.NO. C6241-019-A

FURUNO ELECTRIC CO., LTD.

FURUNO

S - 2



ITEM	NAME	MATERIAL	Q'TY	DWG.NO.	REMARKS
品番	品名	材質	数量	図番	摘要

承認 APPROVED	Oct.22.'84	三角法 THIRD ANGLE PROJECTION	名称 TITLE: 指示器総合回路図 FD-160 DISPLAY UNIT INTERCONNECTION
検図 CHECKED	Oct.22.'84	尺度 SCALE: /	
製図 DRAWN	Oct.15.'84	重量 WEIGHT: kg	図番 DWG.NO. C6241-026-C

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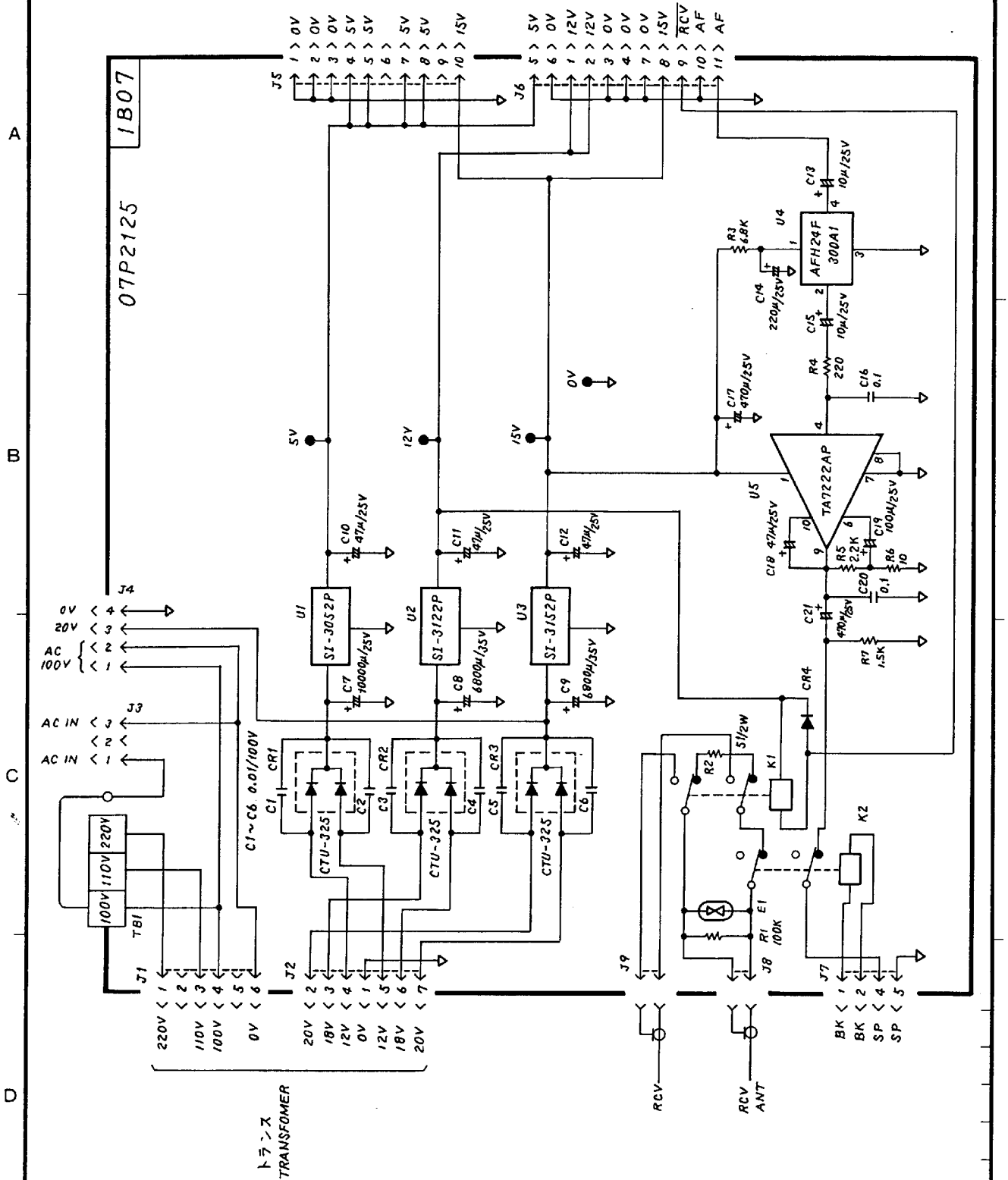

FD-160

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS

承認 APPROVED	FEB. 6 '85	三角法 THIRD ANGLE PROJECTION	名称 TITLE 07P2125 電源基板 POWER P.C.B.
検図 CHECKED	Feb 5 '85	尺度 SCALE /	
製図 DRAWN	4 FEB. '85 S.M	重量 WEIGHT kg	図番 DWG.NO. C6241-034-B

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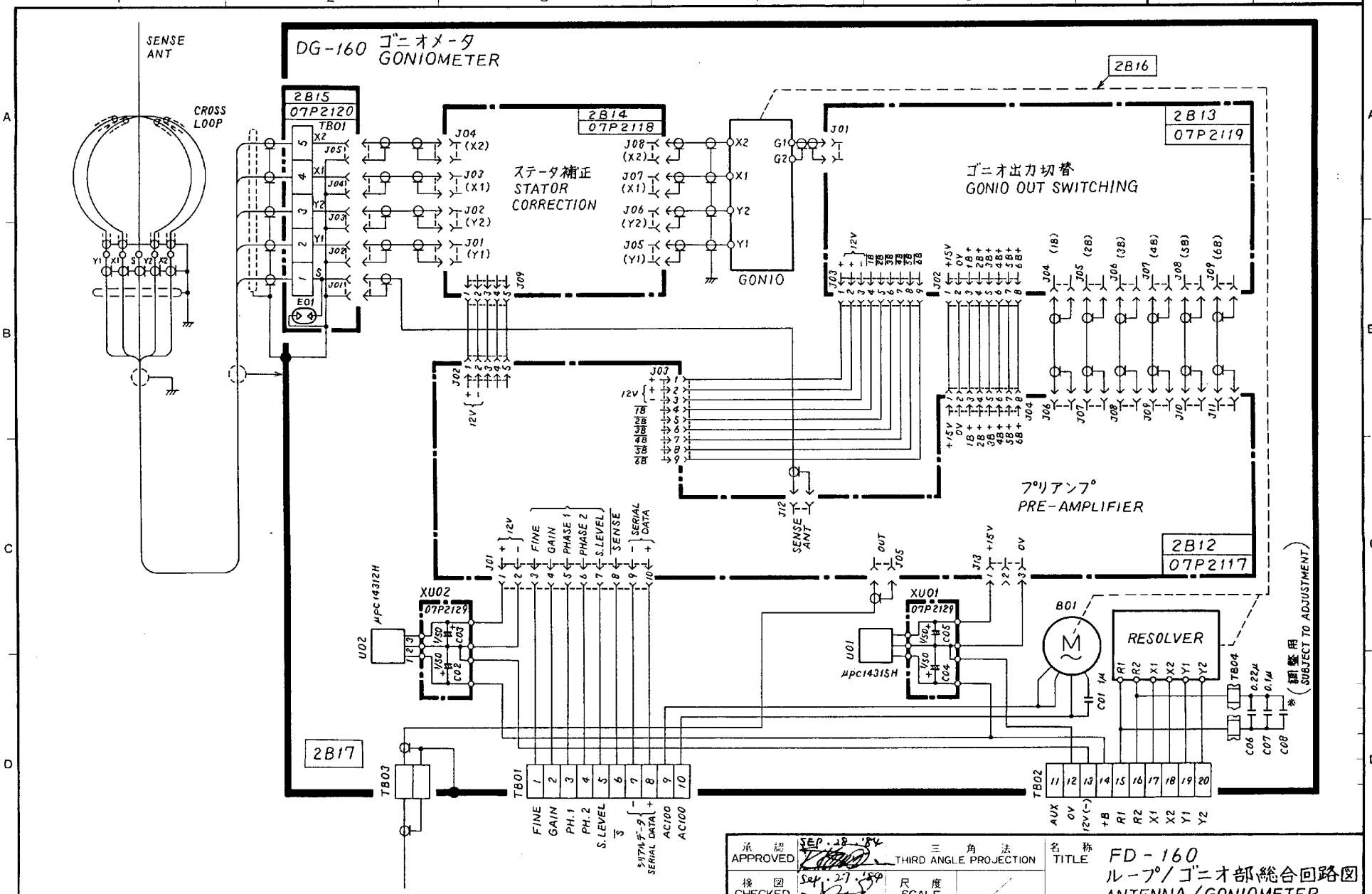

承認 APPROVED	Sep.28.'84	三角法 THIRD ANGLE PROJECTION	名称 TITLE: FD-160 ループ/ゴニオ部総合回路図 ANTENNA/GONIOMETER
検図 CHECKED	Sep.27.'84	尺度 SCALE	
製図 DRAWN	Sep.20.'84	重量 WEIGHT kg	図番 DWG.NO. C6241-022-C

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